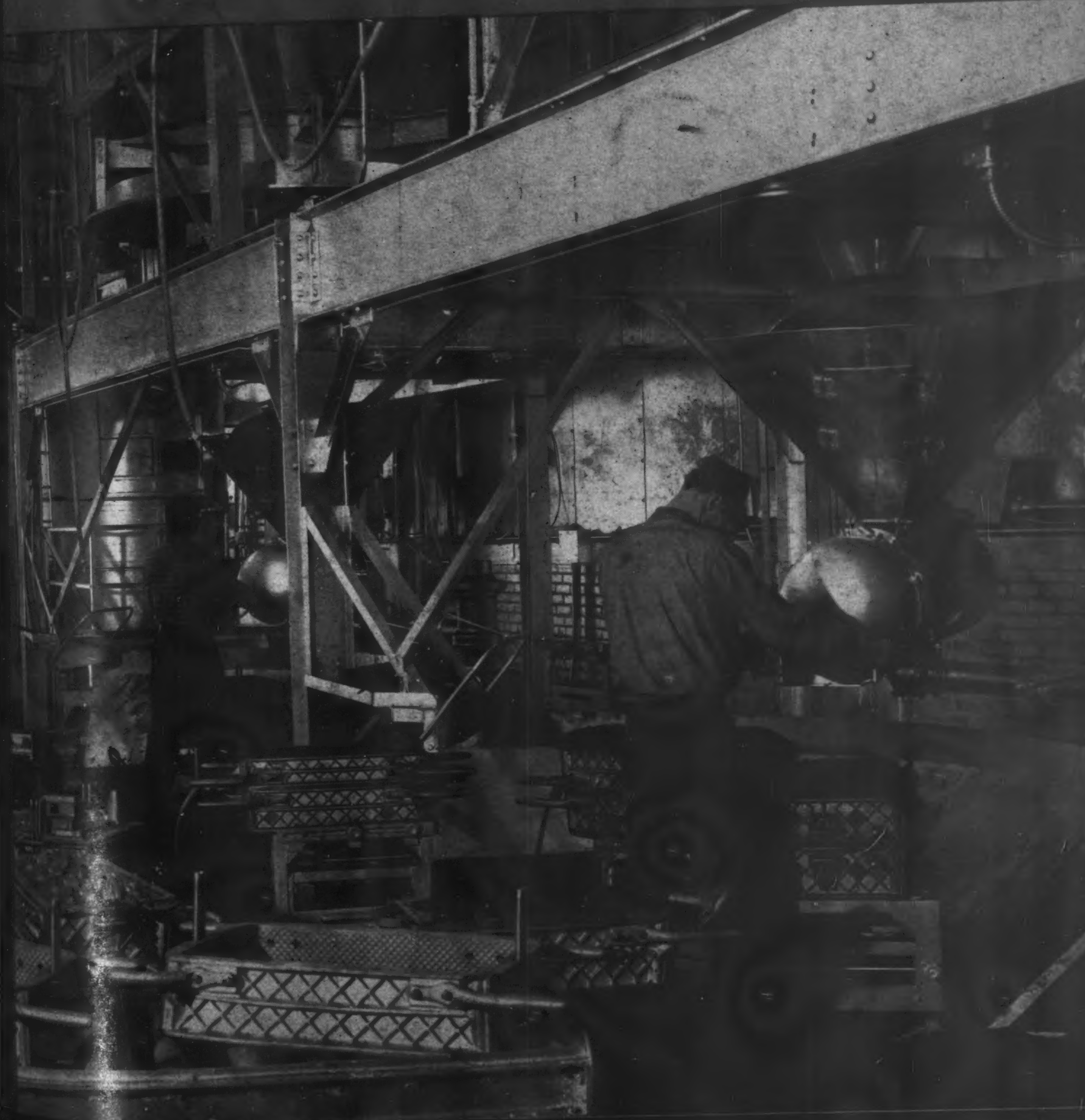
# American Foundryman

JUNE 1948

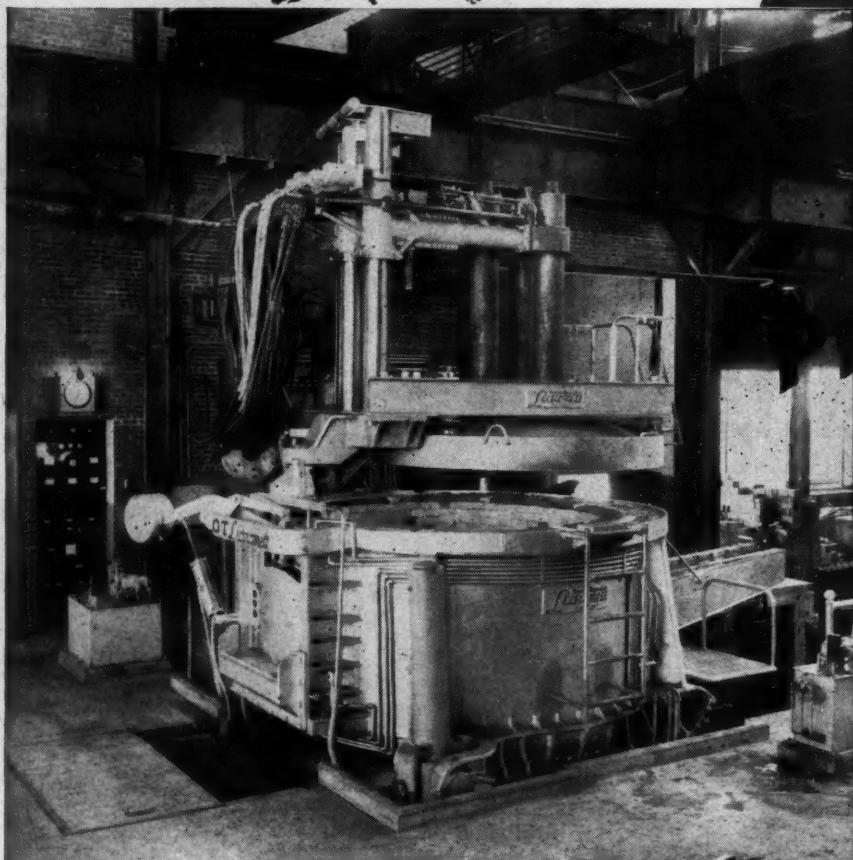
★ THE FOUNDRYMEN'S OWN MAGAZINE



MOORE RAPID *Lectromelt* FURNACES

# TOP CHARGING

## LOWERS PRODUCTION COSTS



*Size OT Lectromelt for melting 12 ton heats. Roof has been raised and swung aside, ready for charging.*

MORE production per man hour is an effective means of lowering production costs and that is exactly what Lectromelt's experience *proven* top charging design can do for you.

The top-charge furnace readily cuts down that interval between heats. The furnace roof is hydraulically raised and swung aside by the operator moving one valve . . . the drop bottom bucket places a full charge . . . hydraulic power returns roof to operating position and the furnace is ready to begin melting again. One user reports a three to five minute power off to power on interval averaged, with 30% more pounds produced per man hour with the top-charge furnace than with a door-charge type.

Lectromelt Top-Charge Furnaces are available in capacities ranging from 100 tons down to 250 pounds.

**PITTSBURGH LECTROMELT FURNACE CORPORATION**

**PITTSBURGH . . 30 . . PENNA.**

*VOLUME IX, NUMBER*

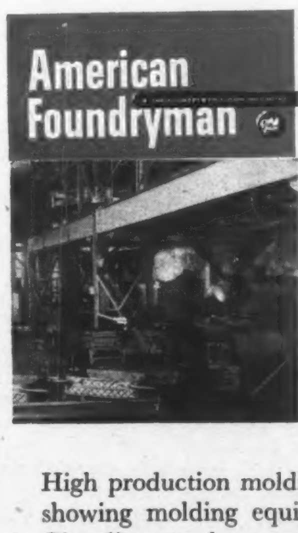
# American Foundryman

*June 1946*

**Official publication of American Foundrymen's Association**

CONTENTS






*The American Foundrymen's Association is responsible for statements or opinions advai by authors of papers printed in its publicati*

Published monthly by the American Foundrymen's As tion, Inc., 222 W. Adams St., Chicago 6. Subscription to members, \$4.00 per year; to non-members, \$6.00 per Single copies, 50c. Entered as second class matter Jul 1938, under the Act of March 3, 1879, at the post Chicago, Illinois.

High production molding operation in a modern mechanized fou showing molding equipment and part of the sand-handling sys Cleanliness and convenience of the operation are evident.

# ★ JUNE WHO'S WHO ★

F. G. Sefing

See: *"Gray Iron Wear Resistance"* . . . Author, F. G. Sefing, was born in Allentown, Pa. . . . Obtained his mechanical engineering degree from Lehigh University, Bethlehem, Pa. . . . In 1924 received his Master of Science degree from Penn State College, Penn State, Pa. . . . Following graduation from college in 1919 became connected with Hudson Motor Car Co., Detroit, as assistant metallurgist . . . In 1920 was named metallurgist at Rockford Drop Forge, Rockford, Ill., . . . From 1924-37 was instructor of metallurgy at Michigan State College, E. Lansing, Mich. . . . Joined International Nickel Co., Bayonne, N. J., in 1937 as research metallurgist . . . Has written quite extensively for the trade press and has been a frequent speaker before many A.F.A. chapters and other technical associations . . . Is chairman of the Executive Committee, Committee on Cooperation with Engineering Schools . . . Is a member of the Executive Committee, Gray Iron Division . . . A member of the Subcommittee on Engineering Properties Symposium and various other A.F.A. committees . . . Member of ASM and A.F.A.

A. C. Den Breejen

Author of *"Japanese Foundry Industry Found Inferior"* is associated with Hydro-Blast Corp., Chicago, as a foundry sand technician . . . Native of Amsterdam, Holland . . . Mr. Den Breejen received his early technical training at Armour Institute of Technology, Chicago, now Illinois Institute of Technology . . . Began foundry work as molding apprentice with W. A. Jones Foundry & Machine Co., Chicago . . . Completed apprenticeship with Nichol-Straight Foundry Co., Chicago, 1933-34 . . . Practical molding experience with Nichol-Straight, Oklahoma Brass & Iron Co., and Ferguson & Lange Foundries, Inc. . . . Foundry instructor at University of Minnesota, 1938-39 . . . Foundry superintendent with Perfection Mfg. Corp., Minneapolis, before associating with Hydro-Blast Corp. . . . A popular speaker before many A.F.A. chapters on sand reclamation and kindred subjects . . . Member of Committee on Sand Grading and Fineness.

D. F. Sawtelle

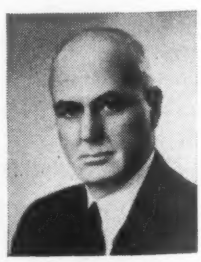
Author of *"Malleable Foundry Coremaking Practice"* . . . Born in New Haven, Conn. . . . From 1916-18 attended Yale University, New Haven, and enrolled in a special course in chemistry . . . Began his industrial career in 1915 with the New Haven Gas Light Co. as analytical chemist . . . In 1928 assumed the position of assistant chief chemist for the Connecticut Coke Co. . . . Two years later (1930) was named metallurgist of the Malleable Iron Fittings Co., Branford, Conn. . . . A member of the A.F.A. Foundry Sand Research Project, Committee on Flowability . . . Has participated in many annual meetings of A.F.A., acting as Chairman or Co-Chairman of technical sessions . . . Contributed a paper to the 1940-42-44 and 46 annual conventions . . . Is a past chairman of the New Haven chapter, ASM, and is president of the Connecticut Foundrymen's Association . . . A member of ASM, Malleable Founders' Society, Steel Founders' Society of America and A.F.A.

R. E. Morey

See, in this issue, *"Preventing Veining and Penetration on Castings Made in Synthetic Sands"* . . . Co-author is J. R. Kattus . . . Mr. Morey was born in Maywood, Ill., and received a chemical engineering degree from the Rensselaer Polytechnic Institute, Troy, N. Y. . . . His industrial career began when he was named junior assistant highway engineer, New York State Highway Department in 1930 . . . Began as a melter at the U. S. Naval Gun Factory, Washington, D. C., (1934) . . . Three years later assumed his present position as metallurgist, Naval Research Laboratory, Washington, D. C. . . . Is active in the A.F.A. Foundry Sand Research Project . . . Is a member of the Committee on Grading and Fineness . . . Has written numerous articles for the trade press concerning molding sands . . . Beside his membership in A.F.A. he is a member of the Washington Society of Engineers.

J. R. Kattus

Co-author, with R. E. Morey, of *"Preventing Veining and Penetration on Castings Made in Synthetic Sands"* . . . Mr. Kattus was born in Cincinnati, Ohio . . . Received his Bachelor of Science degree in metallurgical engineering from Purdue University, West Lafayette, Ind., in 1944 . . . Prior to attending Purdue he was enrolled at the University of Cincinnati . . . Became associated with Wright Aeronautical Corp., Cincinnati, in 1942-43 as a co-op student . . . In 1944 joined the staff of Naval Research Laboratory, Washington, D. C., as research metallurgist . . . Is a member of ASM.



T. G. Johnston

The author is metallurgical engineer, Republic Steel Corporation, Cleveland . . . For 12 years he was chemist, in charge of melting, U. S. Pipe & Foundry Co., Bessemer, Ala. . . . Was general superintendent of the same plant for 14 years . . . For the past 10 years has maintained his present position in the Pig Iron Division, Republic Steel Corporation . . . Was instrumental in helping found the A.F.A. Birmingham District chapter . . . He is an active committee member of the Cupola Research Project . . . A member of A.F.A., affiliated with the Northeastern Ohio chapter, he was

Chairman Banquet Committee for the Golden Jubilee Foundry Congress and Foundry Show . . . Mr. Johnston is author of *"50 Years Progress in Foundry Pig Iron."*

**G. H. Found**

G. H. Found, metallurgical department, Magnesium Division, The Dow Chemical Co., Midland, Mich., is author of the paper *"Magnesium Alloy Castings—Relative Significance of Design and Metallurgical Factors to Serviceability"* . . . Born in Boston in 1918 . . . A graduate of Princeton University, Princeton, N. J. . . .. He was awarded his Bachelor of Arts degrees in physics (1940) . . . Attended the Graduate School of Yale University, New Haven, Conn., where he was laboratory assistant, he received his Doctor of Engineering degree in metallurgy in 1943 . . . During the summer of 1941 was a member of the technical staff of the Bell Telephone Laboratory, Inc. . . . The following summer (1942) was associated with the New Jersey Zinc Co. . . . At present is in charge of fatigue and serviceability studies, The Dow Chemical Co., which firm he joined in 1943.

**Basil Gray**

Mr. Basil Gray presents in this issue *"Producing Bomb Castings by Use of the Core Barrel . . .* Holds the position of special director, English Steel Corp. Ltd., Sheffield, England . . . Active IBF member.

**R. W. Lindsay**

See: *"The Metallurgical and Engineering Status of Cast Irons"* . . . Mr. Lindsay was born in Boston, Mass., in 1912 . . . Obtained his Bachelor of Science degree in chemical engineering from Tufts College, Medford, Mass., in 1933 . . . Two years later (1935) earned his Master of Science degree in metallurgy from Massachusetts Institute of Technology, Cambridge . . . Went on to receive his Doctor of Science degree in physical metallurgy in 1938 from the same institution . . . Recently joined the staff of Pennsylvania State College . . . A frequent writer for the trade press concerning various phases of cast iron metallurgy.



# A. F. A. CHAPTER DIRECTORY

33

**BIRMINGHAM DISTRICT CHAPTER**
*Secretary-Treasurer*—Fred K. Brown, Adams, Rowe & Norman, Inc., 729 Brown-Marx Building, Birmingham, Ala.

**CANTON DISTRICT CHAPTER**
*Secretary*—C. E. Shaw, American Steel Foundries, E. Broadway, Alliance, Ohio.

**CENTRAL ILLINOIS CHAPTER**
*Secretary*—C. W. Wade, Caterpillar Tractor Co., Peoria, Ill.

**CENTRAL INDIANA CHAPTER**
*Secretary*—Robert Langsenkamp, Langsenkamp-Wheeler Brass Works, 1234 Shelby Avenue, Indianapolis.

**CENTRAL NEW YORK CHAPTER**
*Secretary*—R. A. Minnear, 330 W. Water Street, Painted Post, N. Y.

**CENTRAL OHIO CHAPTER**
*Secretary*—Karol W. Whitlatch, 439 N. Richardson, Columbus, Ohio.

**CHESAPEAKE CHAPTER**
*Secretary-Treasurer*—L. H. Denton, Baltimore Convention Bureau, 1714 O'Sullivan Building, Baltimore 2, Md.

**CHICAGO CHAPTER**
*Secretary*—L. C. Smith, Peninsular Grinding Wheel Co., 205 W. Wacker Drive, Chicago.

**CINCINNATI DISTRICT CHAPTER**
*Secretary*—Wm. Hoppenjans, Jr., Star Foundry Co., Third and Main Streets, Covington, Ky.

**DETROIT CHAPTER**
*Secretary*—R. E. Cleland, Eastern Clay Products, Inc., United Artists Building, Detroit 26, Mich.

**EASTERN CANADA AND NEWFOUNDLAND CHAPTER**
*Secretary-Treasurer*—Robert E. Cameron, 4775 Sherbrooke Street, Westmount, Que., Canada.

**METROPOLITAN CHAPTER**
*Secretary*—George E. Hadzima, Robins Conveyors, Inc., Passaic, N. J.

**MEXICO CITY CHAPTER**
*Secretary*—N. S. Covacevich, Casa Covacevich Foundry Supplies & Equipment, Mexico City, D. F., Mexico.

**MICHIANA CHAPTER**
*Secretary*—V. S. Spears, 2013 Linden Ave., Mishawaka, Ind.

**NORTHEASTERN OHIO CHAPTER**
*Secretary*—Gilbert J. Nock, Nock Fire Brick Co., 1243 E. 55th Street, Cleveland.

**NORTHERN CALIFORNIA CHAPTER**
*Secretary*—J. F. Aicher, E. A. Wilcox Co., San Francisco.

**NORTHERN ILLINOIS-SOUTHERN WISCONSIN CHAPTER**
*Secretary*—A. P. Rose, National Sewing Machine Co., State & Meadows Streets, Belvidere, Ill.

**NORTHWESTERN PENNSYLVANIA CHAPTER**
*Secretary*—H. L. Gebhardt, 232 W. 21st Street, Erie, Pa.

**ONTARIO CHAPTER**
*Secretary*—G. L. White, Westman Publications, 137 Wellington Street, W., Toronto, Ont., Canada.

**OREGON CHAPTER**
*Secretary*—A. R. Prier, Oregon Brass Works, E. 10th & Salmon Streets, Portland, Ore.

**PHILADELPHIA CHAPTER**
*Secretary-Treasurer*—W. B. Coleman, W. B. Coleman & Co., Ninth and Rising Sun Avenue, Philadelphia.

**QUAD CITY CHAPTER**
*Secretary-Treasurer*—W. H. Sundeen, 2941 11th Avenue A, Moline, Ill.

**ROCHESTER CHAPTER**
*Secretary-Treasurer*—Carl B. Johnson, Symington-Gould Corp., 25 Lincoln Avenue, Rochester, N. Y.

**SAGINAW VALLEY CHAPTER**
*Secretary-Treasurer*—M. V. Chamberlin, 1810 Vermont Street, Saginaw, Mich.

**ST. LOUIS DISTRICT CHAPTER**
*Secretary-Treasurer*—Lee H. Horneyer, 7 N. Grand Avenue, St. Louis.

**SOUTHERN CALIFORNIA CHAPTER**
*Secretary*—Henry E. Russill, 2449 Cudahy Street, Huntington Park, Calif.

**TEXAS CHAPTER**
*Secretary-Treasurer*—H. L. Wren, P. O. Box 305, Houston, Texas.

**TOLEDO CHAPTER**
*Secretary-Treasurer*—Gerald R. Rusk, Freeman Supply Co., 1152 E. Broadway, Toledo, Ohio.

**TWIN CITY CHAPTER**
*Secretary-Treasurer*—Alexis Caswell, Manufacturers' Association of Minneapolis, In 200 Builders Exchange Building, Minneapolis.

**WESTERN MICHIGAN CHAPTER**
*Secretary*—Rudolph Flora, Clover Foundry Co., 11th Street & Clay Avenue, Muskegon, Mich.

**WESTERN NEW YORK CHAPTER**
*Secretary*—Leo A. Merryman, Tonawanda Iron Corp., No. Tonawanda, N. Y.

**WISCONSIN CHAPTER**
*Secretary*—Russell J. Anderson, Belle City Malleable Iron Co., 1442 Forest Street, Racine, Wis.

**UNIVERSITY OF MINNESOTA STUDENT CHAPTER**
(Inactive for Duration.)

# PRESIDENT OF EQUIPMENT GROUP CALLS 1946 FOUNDRY SHOW "BEST EVER"

A POLL of those who attended and those who exhibited at the recent "Golden Jubilee" Foundry Congress and Foundry Show at Cleveland undoubtedly would express the practically unanimous opinion that it was the "best ever." The exhibits seemed constantly attended by large, and more important, highly interested groups of foundrymen.

Considerable time, materials, and designing personnel are required to manufacture and test new equipment. During the war, all of these were at a great premium, with the result that but little new designed equipment has been available for the past several years. The experience gained during the war has been and will continue to be of tremendous value to designers of foundry equipment. The exhibition provided the opportunity of displaying some items of new equipment, of presenting designs of others, and just as important, of discussing problems with the users themselves. Equipment manufacturers know and freely admit that foundrymen who have actually used an item for a period of months or years are the real judges of its worth.

Foundrymen and equipment manufacturers alike face many problems in the future. During the war occurred the huge expansion of all metal processing facilities, which means that competition will be keen not only between the foundries themselves but also in methods of production. Foundries must be "good places in which to work," and modern equipment, good housekeeping, and trained leaders will most certainly enable them to attract the necessary labor.

It is believed that biennial exhibitions of the type held in Cleveland are of great value to both the equipment manufacturing and foundry industries. Manufacturers are provided with the opportunity of presenting their equipment to interested prospects. Their appreciation is indicated by the care and planning of the exhibits. All agree that the A.F.A. staged one of the largest and most beautiful industrial exhibits ever held. Foundrymen could see the most modern equipment, some in actual operation, and could discuss their problems with all who are most interested in providing a solution. The American Foundrymen's Association is to be highly commended and sincerely congratulated upon the success of its Fiftieth Annual Meeting and Foundry Show.

Thomas Kaveny Jr.

Thomas Kaveny, Jr., *President,*
Foundry Equipment Manufacturers Association.

*Continuity view of the Upper Level, Lakeside Hall, showing exhibits at the A.F.A. 50th Annual Convention.*

# PRODUCING BOMB CASTINGS

## by use of the CORE BARREL

**Basil Gray**

**English Steel Corp. Ltd.**
**Sheffield, England**

DURING THE WAR the output of the steel foundries of Great Britain was more than doubled by the additional output from new, government sponsored factories managed by existing firms, and by converted iron foundries. These projects, the castings produced as a result of them and the methods employed could well supply appropriate subjects not merely for one but for several exchange papers. Some of the mass-production foundries designed to produce bomb cases and tank track links, for instance, were so fully mechanized that castings up to 500 lb. in weight were produced with a labor force comprising, in some cases, 80 per cent women.

### Good Cooperation

In the many developments in tank armor castings the leading producers co-operated to a degree previously unknown, with excellent results, as shown by the improvement in quality and technique that followed. The co-operation, started in this way, has engendered a new spirit in the steel castings industry of Great Britain, and today the British Steel Foundry Technical Association, which in itself would form the subject of an interesting talk, is a live organization in which members of some 80 per cent of the foundries take an active part with the fullest interchange of ideas and information.

Production of the "grand slam" and "tallboy" bombs was chosen as a subject, not because it supplied front-page news in the public press a year ago, but because the method to be described included a revised version of an old and little-known technique which, at least, in a limited field, has proved of great value.

### Bomb Production

Production of these bombs (Fig. 1) has been illustrated in American technical journals with a creditable description, largely deduced from photographs and brief technical data, but the reasons for adopting such an unusual method for constructing the core must, nevertheless, have been rather puzzling to many readers, and a detailed description may be of interest.

*Molding with a Strickle.* The striking up of a mold with a strickle (sweep) is almost as old as the art of founding itself, but the striking up of cores on a core barrel, although also an old practice, is less well known. It is used in Great Britain, to some extent, by a few heavy steel foundries as well as by iron foundries for jobbing work, but not often for mass production work.

**Twenty-fifth in an unbroken series of annual exchange papers—1922-1946—from the Institute of British Foundrymen to the American Foundrymen's Association . . . the present paper is an example of the value of this broad exchange of knowledge and practical developments for the common advancement of the foundry industry and international understanding.**

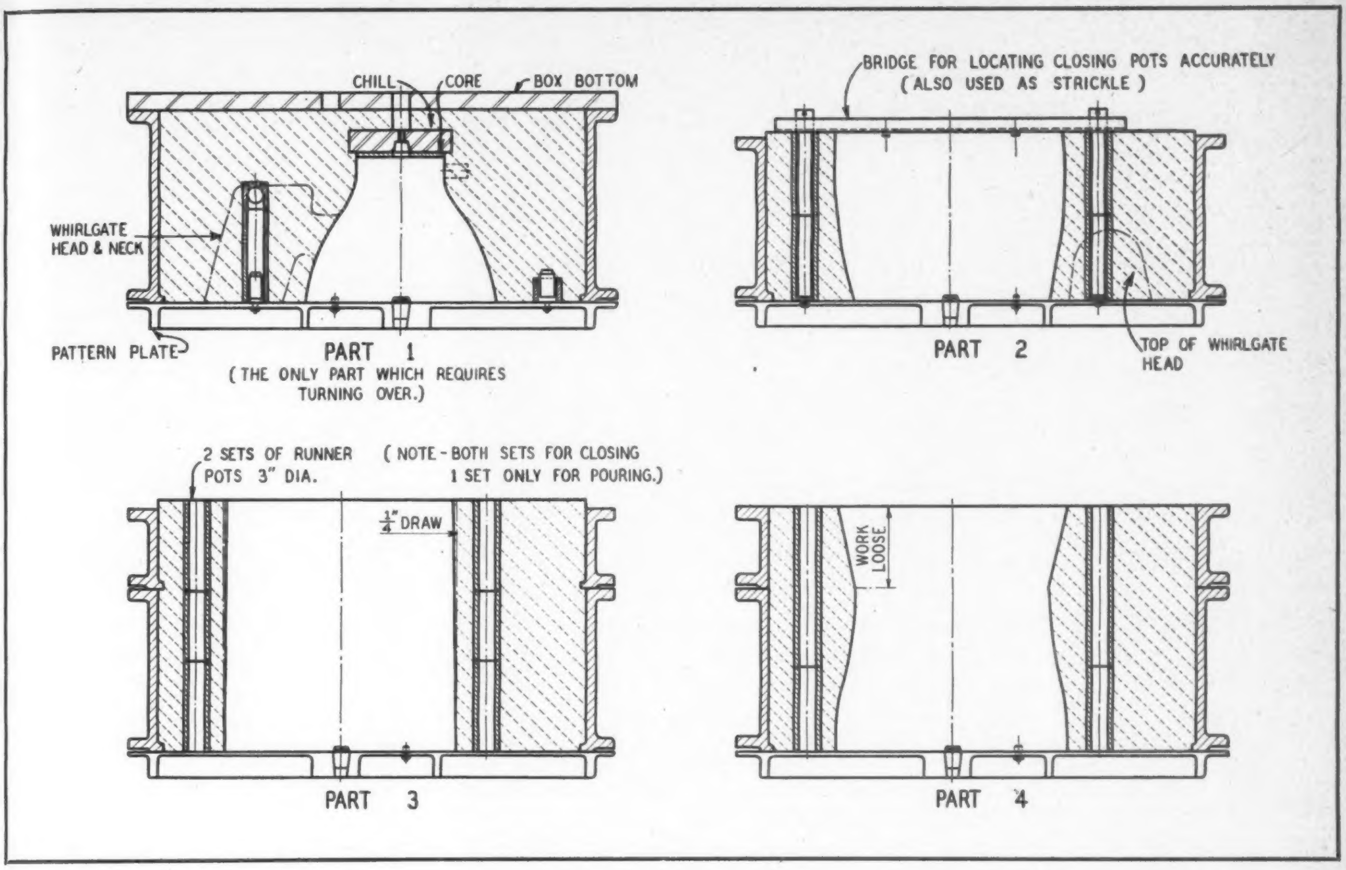
### From Bells to Bombs

Nearly 100 years ago cast steel church bells were made in some quantities by the author's firm, using a similar process. The mold was formed on a plate with the strickle (sweep) post fixed to it, and a bell-shaped cast iron piece, with many perforations to allow the escape of gases and moisture, was threaded over it. Loam was applied, struck up to shape with a strickle board and dried. A clay mixture came next, which was strickled to the shape of the outside of the bell and also dried. The cope was then rammed up by ordinary methods, using the clay as the pattern or "thickness," as it used to be called. When the cope had been lifted the clay "thickness" was broken away and the mold was completed.

Earlier samples of the 6-ton "tallboy" were made by jobbing methods, using a barrel core. They had a number of successes, such as the penetration of the "U" boat pens at L'Orient and the collapse of the entrances to an underground garage for the V-1 rocket planes.

*Foundry Conditions.* The demand for maximum output which followed came at a time when all mechanized foundry and the heavy molding machines were fully occupied on tank castings and similar important work, but when the heavy molding pits and their crews were comparatively slack owing to the cessation of the

Presented at a Steel Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 10, 1946.




demand for heavy war production plant. In the same way, steel was not available in the convenient amounts obtained from the electric furnace, and only the 40-ton or 60-ton acid open-hearth furnaces could supply the quantity necessary.

The grand slam bomb required 10 tons of steel and the tallboy 6 tons, so that the foundry had to assemble eight tallboy molds or four grand slams at a time to make up a heat. One pit, enlarged to hold 12 boxes of tallboys, and a smaller one to hold four were available, but these pits could be served only by one crane.

Cycle for melting was 14 hr. from tap to tap, and it was essential for the foundry to be able to produce molds sufficiently fast to take successive heats if the rate of production was to be maintained. The molds could be removed from the pit after 8 hr. and knocked out after 24 hr., so that some 24 sets of boxes and tackle were required.

It was evident that the time taken to assemble the molds with the one crane was going to be the bottleneck in production, and that everything possible must be done to speed up the process.

*Fig. 1—Photograph showing (bottom) the "grand slam" and (top) "tall boy" bombs.*

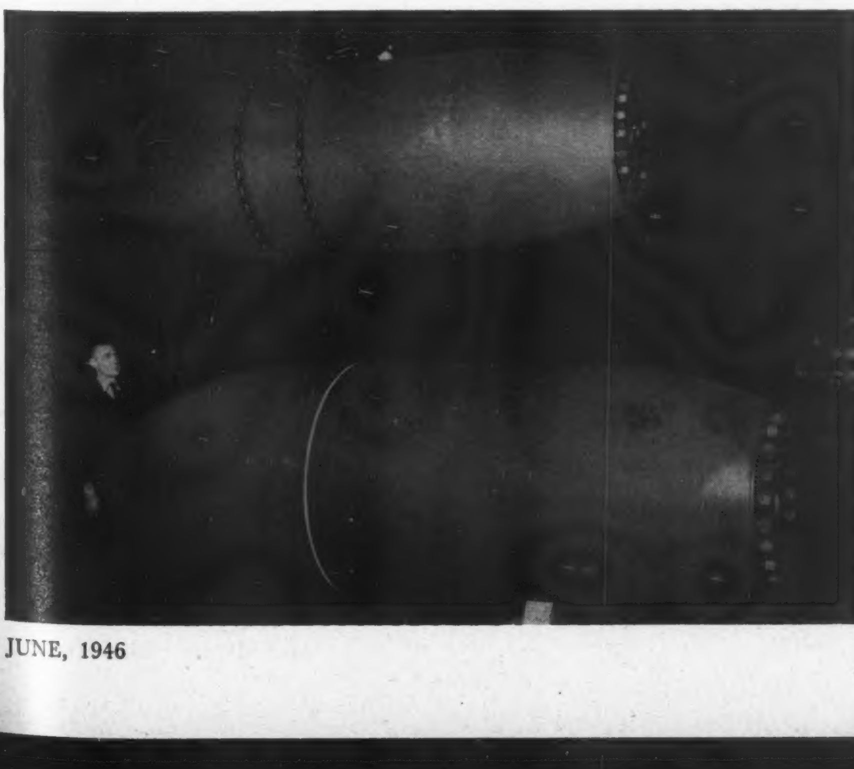


*Fig. 2—Drawing showing design of molding boxes.*

### Special Plant Out

In the 5th year of war the installation of a special plant was out of the question, owing to the tremendous demands of D-day on the engineering shops, and the methods of production now described were an improvisation designed to meet the special circumstances.

A high degree of accuracy was required, both in thickness of wall and in streamline form, to ensure true flight. The poor quality of timber available for patterns was likely to distort, and the problem of obtaining the large numbers of machined and pinned boxes required

*Fig. 3 (top)—Boxes at molding stations. Note method of clamping. Fig. 4 (bottom)—Method of drying boxes with portable coke-fired stoves.*

for rapid and accurate closing seemed insuperable under the conditions prevailing.

On the other hand, sufficient lathes were available to machine the outsides, which were therefore given a machining allowance. One or two were cast to size and proved acceptable, but the molds took too long to close and more time was required for finishing in the dressing shop where the labor force was short.

*Molds.* Molding equipment followed ordinary practice, with patterns in sections on plates, and ramming by pneumatic hammer. Five boxes of special design, as shown in Fig. 2, were used for the tallboy, while the heavier bomb, of which fewer were needed, was made in a similar way, but in the foundry's standard shallow 6 × 4-ft. boxes clamped together in suitable numbers to bring the joints to the right level (Fig. 3).

Figure 2 shows the bottom part as molded, with a heavy chill, separated from the top of the pattern by a thin core. The chill serves to locate the core and chills the heavy nose end of the bomb. When ramming up is completed the sand is strickled off and the bottom plate bolted on. The other boxes shown call for little explanation, but a point worth noting is the fire clay pipe down-runner to the side head feeding the bottom.

This type of head with a tangential runner is known in England as a "whirlgate," and has been much used in recent years. The down-runner and a similar dummy runner on the other side of the pattern were used with the help of a close fitting rod to locate the boxes in closing. The method proved successful and presents advantages over the more usual ball-and-socket device often employed in such circumstances. The boxes were dried with portable coke-fired stoves (Fig. 4).

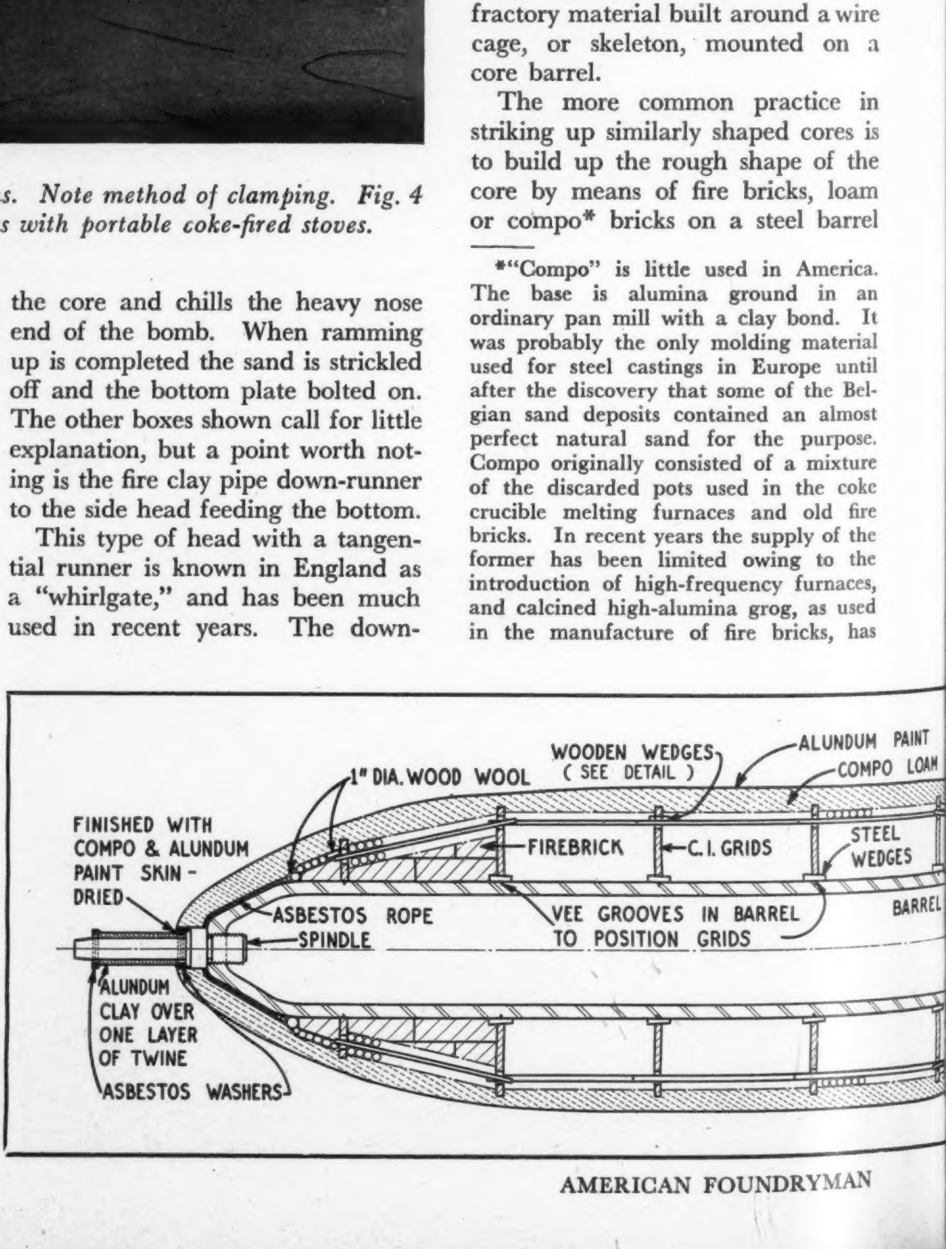
*Structure of the Main Body Core.* Normal methods of core construction were considered but were not adopted because of the difficulty of obtaining satisfactory wood and because the slight adjustments that might be required to the dimensions would be more difficult. A still stronger argument was that the cores used in the earlier bombs had proved successful, and few foundrymen are in a hurry to abandon a success in search of problematical economies.

### Core Barrel

As can be seen in Figs. 5 and 6, the main body core consists of refractory material built around a wire cage, or skeleton, mounted on a core barrel.

The more common practice in striking up similarly shaped cores is to build up the rough shape of the core by means of fire bricks, loam or compo* bricks on a steel barrel

*"Compo" is little used in America. The base is alumina ground in an ordinary pan mill with a clay bond. It was probably the only molding material used for steel castings in Europe until after the discovery that some of the Belgian sand deposits contained an almost perfect natural sand for the purpose. Compo originally consisted of a mixture of the discarded pots used in the coke crucible melting furnaces and old fire bricks. In recent years the supply of the former has been limited owing to the introduction of high-frequency furnaces, and calcined high-alumina grog, as used in the manufacture of fire bricks, has



wound with wood rope; this rough, brick-built shape being covered with refractory material and strickled off to shape. The time required for building up a core in this manner is considerable, and the result is of rather solid construction, allowing less chance of contraction and consequent risk of "pulls" even though the barrel is pulled out as soon as the steel has set sufficiently.

It was considered that with a hollow cage the core would be quicker to make and the risk of "hot pulls" would be eliminated. Its construction could be broken down into simple operations requiring little skill, thus releasing the expert molders for the finishing work.

*Fig. 6—Method of constructing main body core.*

### Inside Skin Good

In practice it has been found that of the many hundreds of these bombs which have now been made not one has been torn by contraction. Furthermore, the inside skin of the castings has been exceptionally good, and one can only conclude that this has been brought about by the absence of severe pressure from contraction between the skin of the casting and the molding material.

*Core Barrel.* Both the tallboy and grand slam bombs are manufactured in a similar way, the only difference being the size of the parts used. Therefore, in giving a description of the tackle the sizes will be given for the tallboy only.

The backbone of the core is a cast steel core barrel 12 ft. 6 in. long, 15 in. outside diameter, with walls 1½ in. thick. As can be seen from the diagram (Fig. 5), the nose end is closed and the tail end has a bridging star fitted. Both the nose end and the star are drilled and tapped to take screwed trunnions.

### Vents Formed

At intervals of approximately 9-in. pitch, 1½-in. diameter, holes are bored or burnt in the barrel to form vents. This is done in order to allow any gases which form during casting to pass through and up the barrel to the atmosphere. At the tail end of the core barrel are two 4½-in. diameter holes.

These holes are used for suspending the cores in a special rack while waiting to be put in the molds, and also for pulling out the barrel after the bomb has been cast. The core rack can be seen in Fig. 6.

At intervals along the barrel, six V-grooves are machined in order to indicate the location of the grids, which are of "open cast" iron about ¾ in. thick.

*Assembly of the Cage.* The core barrel described is supported on two stands by the trunnions, and the six cast iron core grids are placed over the barrel and wedged into position over the marking grooves by two steel wedges. Through the holes in the grids mild steel rods of ½-in. diameter are passed and secured into position by soft wood wedges.

### Nose End Solid

At the nose end of the core the cage is made solid by packing between the grid and the barrel with fire brick. This is done in order to strengthen the structure to withstand the upward pressure of the steel during pouring, but is not really necessary, as will be explained later.

The grid at the nose end, as can be seen in Fig. 6, has ½-in. diameter rods cast in. These are bent over the fire brick and wired down to give the desired shape.

Over this steel and iron cage 1-in. diameter wood rope is wound. This is done by one operator turning the whole barrel by means of a handle while another operator feeds the rope on. The rope has to be fed on carefully so that it forms a tight continuous skin.

*Coremaking.* The coremakers now take over the assembly, which is still on the pedestals or stands. Their

been substituted. Where an especially high quality of face is required, as in the interior of the bombs, the mixture is made of the grog only, ground to a specified mesh. In Germany a similar mixture still is used, almost universally, except in light production castings. It is highly refractory when of good quality, and is mainly used for heavy castings. In this case it is used because it can be applied in a pasty condition, and is thus suitable for loam molding.

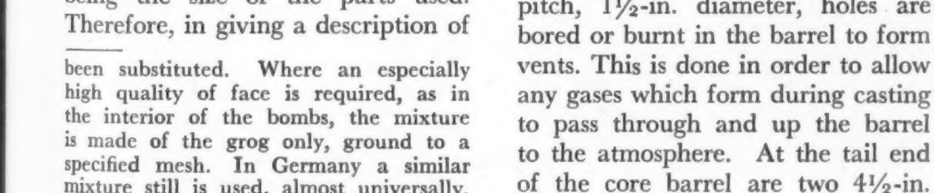



*Fig. 5—Sectional drawing showing bomb core construction.*

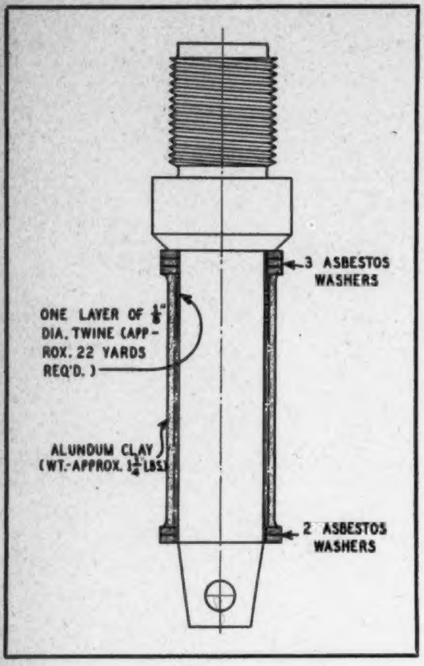



*Fig. 7—Sketch showing core locating pin.*

first operation is to cover the whole of the structure with semi-stiff "compo" loam. When the structure has been thus covered, long lengths of reinforcing ¼-in. diameter rod are laid along the length of the barrel and pressed down into the loam. Wire, 1/16-in. diameter, is then wound tightly round the barrel at 2-in. pitch, holding the rods in position and making further reinforcement.

After drying for 4 hr. at 400° F. in special stoves, the core is taken out and, while still warm, a further layer of wet "compo" loam ¾-in. thick is added and roughly strickled to shape. Due to the heat already in the core this layer of loam dries fairly rapidly, and the coremaker immediately applies a coating of chamotte (ground calcined fireclay) strickling to shape all the time.

This is followed by a coat of alundum paint. The whole core is then placed back in the stove and dried for an additional 2 hr. Between operations the strickle board is adjusted to give the thickness desired in each layer. The core is checked for size before and after drying, a profile template as well as calipers for diameter being used.

*Making Nose End Core.* The nose end core is built up on a specially screwed pin which replaces the trunnion in the main barrel. The other end of the pin is tapered to fit into the chill plate of cast iron in the bottom of the mold (Fig. 7). Both the trunnion and the chill plate are carefully machined as they form the locating point of the core.

The pin shown in Fig. 7 is mounted on a special strickling machine. One layer of ⅛-in. diameter twine is wound on and a coating of alundum loam ⅜-in. thick is strickled over the twine. An asbestos washer is fittted, as shown in Fig. 7. The whole of the trunnion is then placed vertically in a stove and dried at 660° F. for 2 hr.

The production department's idea of a cage to replace the old laborious method was accepted with approval by the experienced coremakers, but they were careful to anchor the longitudinal rods firmly to the bottom by bending the ends into a hook. Sufficient attention had certainly not been given to this point in the original design.

As production increased, inexperienced molders were brought into the work and this part was not so well done, with the result that the steel broke through a number of times owing to the core slipping up the barrel. To overcome this the core was filled in (at the nose end), although no trouble was experienced when the experts were on the job. These were the only occasions of core failure throughout the work.

### Special Coremaking Tackle

*Core Drying Stoves.* Owing to the output of bombs required it was necessary to design and erect a battery of special core-drying stoves, capable of quick loading and unloading. The design finally adopted, as shown in Fig. 8, consists of two trestles around which a brick wall is built.

Over the top of the brick wall light asbestos lined steel hoods are fitted, while running the length of the chamber is a brick-built flue with outlets for hot air at intervals. The hot air is introduced by means of fans coupled to portable coke-burning stoves. A plate on either side of the air inlets induces a circulation around the bomb and an exit through vents at the bottom of the outer wall.

Temperature is controlled by thermocouples introduced at intervals along the stove. The cores are moved about during manufacture on the special lifting beam shown in Fig. 6.

*Core Transport Bogies.* Owing to the geography of the shops it was necessary to transport the cores across two bays. In order to do this

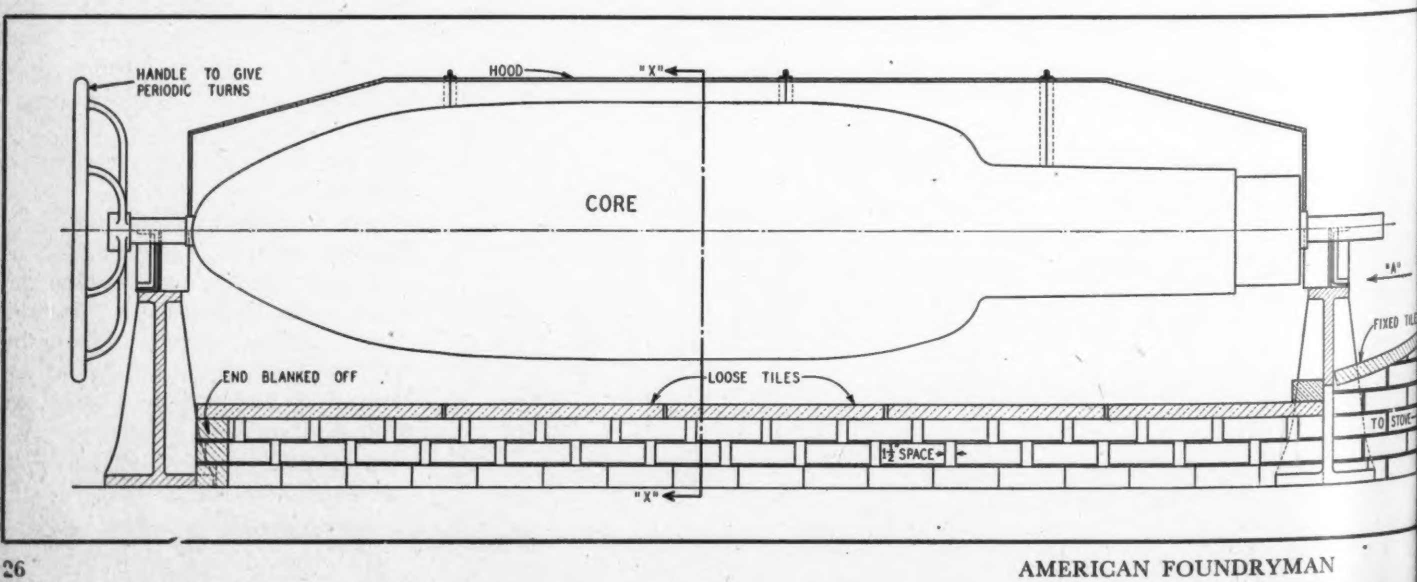



*Fig. 8—Diagrammatic sketch of drying stoves for special bomb cores.*

without damaging the core a special bogie was made of stock materials.

The core is rested on the bogie trestles and the trestle at the nose is pivoted, allowing the core to be up-ended by means of an overhead crane while still on the bogie, thus avoiding damage to the body of the core. The bogie is hauled by a locomotive on a carefully timed schedule, and is also used for the transfer of molding boxes.

*Core Storage Rack.* Figs. 9 and 10 show cores hanging on storage racks. This serves not only to store the cores but also as a means of holding them while the temporary trunnion is replaced by the locating pin with its refractory covering. Otherwise, this would have to be done while the core was hanging in the crane, which would take too long as the joint has to be made up and dried with a blow lamp. The core can be taken from the rack and set in the mold in a few minutes.

*Assembling the Mold.* The three bottom boxes often are assembled ready outside the pit to save time, and Fig. 10 shows two sets side by side, into one of which the core is being lowered. The woman standing on the edge of the mold is holding the wooden wedges with which the mold is temporarily stayed.

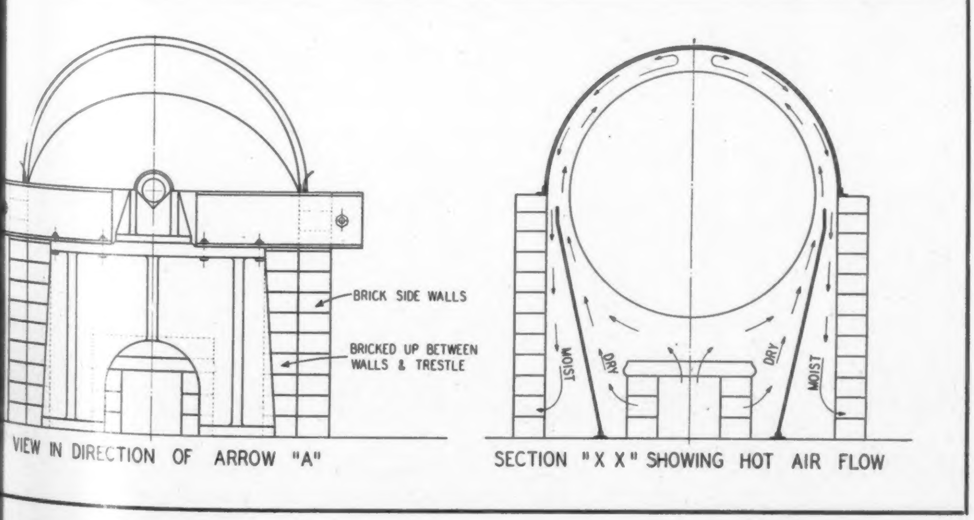
A hole is left in the bottom mold through which one molder can guide the core centering pin into its socket in the chill. A core is used to fill the hole when core setting is completed.

The remaining boxes are lowered into position and the whole clamped up in the usual way. The core is held down by the special bar, which in turn is fastened to the box by the rings and wedges. The trunnion projecting through the holding down bar can be adjusted sideways by wedges to center the core in the mold, and the adjustment of the holding down pressure is also obtained by a wedge lightly driven between underside of bar and barrel.

Care must be taken in this operation as the wedges sometimes come loose, if left for an hour or so, owing to the contraction of the barrel when cooling from the drying operation.

The arrangements described achieved their object in minimizing the time taken to assemble a mold to

*Fig. 9 (top)—Bomb cores hanging on storage rack. Fig. 10 (bottom)—Two sets of bottom boxes (3) assembled outside the pit to save time, with core being lowered into one set.*



the extent that on several occasions the men closed a full cast of eight molds, from start to finish, in less than 3 hr., using only the one crane.

*Casting.* The steel in the smaller bomb is run with a 1¾-in. diameter nozzle in about 1 min. 40 sec. when the ladle is full, and care is taken to ignite the gases from the core as soon as they start to come out from the barrel. These gases were the principal cause of anxiety, as a hollow core had not been tried before and it was not known whether there would be danger of explosions.

In practice, no explosions occurred unless the steel broke in, as in the few cases previously mentioned. Even then there was no "blow" if pouring was stopped at the first indication of trouble, and at no time was the explosion dangerous or even alarming to those used to dealing with heavy steel castings.

**Table 1**

Bomb Steel Analysis

| *Element* | *Content, per cent* |
|---|---|
| Carbon | 0.30 — 0.34 |
| Chromium | 3.2 — 3.5 |
| Molybdenum | 0.50 — 0.60 |
| Manganese | 0.50 — 0.70 |
| Nickel | 0.50 max. |
| Silicon | 0.35 " |
| Sulphur | 0.030 " |
| Phosphorus | 0.030 " |

### Core Removal

One-half hr. after casting the core barrel is pulled out with the overhead crane, the cast iron grids fastened to it are broken in the process and the core is thus most thoroughly eased. The full boxes seen on the right (Fig. 10) are stripped after 24 hr. The heads are burnt off hot and the castings charged into a furnace where they are annealed at a temperature of 1830° F.

*Fig. 11 (above)—Special fixture for oil quenching the bomb casting. Fig. 12 (right)—Shot blasting the bomb casting.*

*Dressing.* The roughing-off operation which follows is laborious with a solid core, but with the core construction used it is much easier. The remains of the grids are hooked with a chain and pulled out, which breaks up the core still further and makes it an easy matter to clean off the greater part of the remaining sand with pneumatic chisels and long bars.

*Steel Used.* A chrome-molybdenum steel with analysis range shown in Table 1 was used in the bomb.

*Heat Treatment.* Final heat treatment of the bomb casting consisted in air or oil hardening from 1688° F. and drawing at 1112-1256° F., according to specifications that were amended from time to time.

A tensile and Izod impact test piece cut radially from a test ring removed at the base of the top head was prepared from representative castings, but each casting was Brinelled in six positions taken spirally from the top to bottom ends. Typical results obtained in these mechanical tests are shown in Table 2.

The special fixture for oil quenching is shown in Fig. 11. It consists of a frame with a fixed ring at one end which is threaded over the nose while the casting is on the furnace car. Another ring sliding on the frame is then pushed over the large end with bars and the casting can then be lifted by the overhead crane to a vertical position and quenched immediately in the oil.

*Finishing.* The inside of the bomb casting is shot blasted in what was a rotating table wheelabrator machine, altered to suit the work. The wheelabrator roof was removed and the bomb slung in its place from a beam. The bomb is rotated by fibre-covered friction wheels bearing on its outside and driven through V-belts by the motor that previously rotated the table.

A long blast pipe with nozzle at right angles is fed up the bomb by means of the winch and wire rope shown in Fig. 12. The success of the core in giving a clean skin results in little further work being required on the inside after shot blasting, except at the nose end which cannot be reached by the shot. A smooth surface is required to avoid danger while filling with explosive, but, in spite of that, welding was seldom necessary.

This is not the place to describe the machining operations, but a few views of the machine shops (Figs. 13 and 14) may be of interest. Figure 15 shows the bomb as carried in the aircraft, its tail being about 22 ft. long.

*Targets.* A short account of the results obtained with the bomb may

**Table 2**

Mechanical Properties Developed in Bomb Steel by Heat Treatment

| *Property* | *Heat Treatment* A[1] | B[2] | C[3] |
|---|---|---|---|
| Tensile Strength, psi | 105,280 | 106,624 | 133,952 |
| Yield Strength, psi | 75,264 | 81,536 | 103,040 |
| Elongation, per cent | 20.5 | 20.0 | 19.0 |
| Reduction in Area, per cent | 49 | 46 | 44 |
| | 30 | 55 | 19 |
| Izod Impact Strength, ft.-lb | 25 | 52 | 18 |
| | 28 | 36 | 20 |

[1]Normalized at 1688° F. (920° C.), drawn at 1256° F. (680° C.)
[2]Oil hardened at 1688° F. (920° C.), drawn at 1256° F. (680° C.)
[3]Oil hardened at 1688° F. (920° C.), drawn at 1112° F. (600° C.)

*Fig. 13—View of machine shop where bomb castings were finished.*

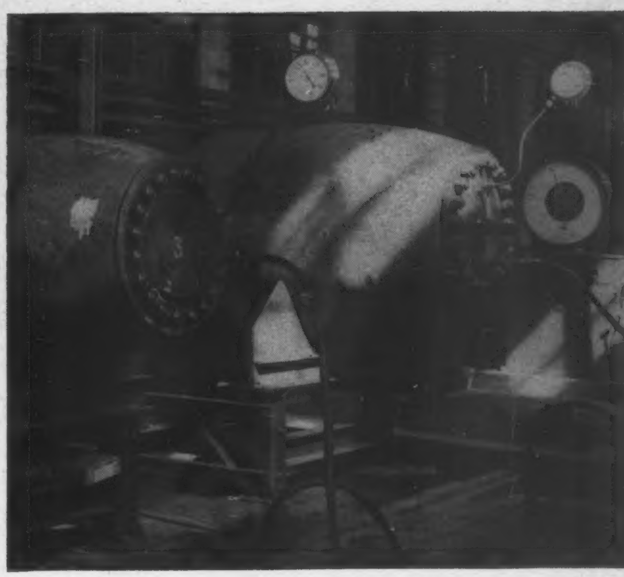


*Fig. 14—Pressure testing of bomb castings.*

*Fig. 15—Finished bomb with fin.*

*Fig. 16—Inside of U-boat pen at l'Orient after bombing.*

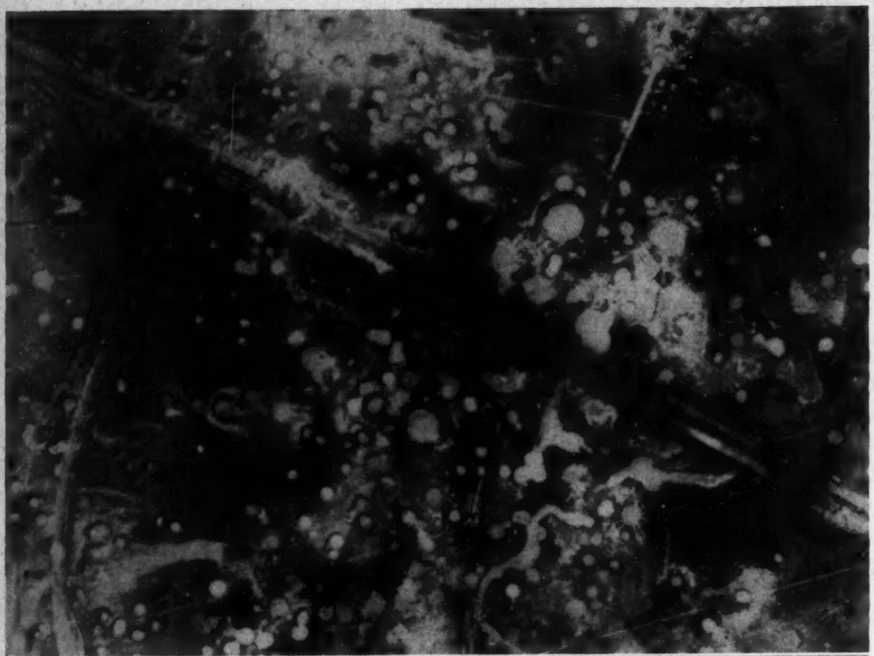


*Fig. 17 (top)—Bielefeld railway viaduct from the air. Fig. 18 (bottom)—Same viaduct (Fig. 17) after near miss by "grand slam" bomb.*

be excused, although the destructive power of the atomic bomb tends to make all earlier bomb types seem obsolete. Nevertheless, the 'Grand Slam' bombs of the R.A.F. had proved themselves the most destructive and at the same time the most accurate bombs of their time.

Mr. Wallace, already famous as the inventor of the "geodetic" construction used in the Wellington bomber, and of the special bombs of another type that were used to blow up the Mohne dam on the River Ruhr, conceived the idea that the detonation of a bomb with a heavy bursting charge that would penetrate deep into the earth's surface would produce earth tremors amounting to a small earthquake.

Penetration was to be obtained by the weight of the bomb and the height from which it was dropped: accuracy, by careful streamlining and a weight that was little affected by air currents; the earthquake by the explosion of a bomb with a light container of high tensile alloy steel and the heaviest possible bursting charge.

The U-boat pens at Hamburg, a relatively small target were hit by 12 out of 18 bombs, a large proportion perforating the 20-ft. roof of concrete with which they are provided. One of the near misses is thought to have sunk two ships at anchor in the harbor nearby. Figure 16 shows the inside of a U-boat pen at l'Orient after a bombing.

Another target, shown in Fig. 17, is the Bielefeld railway viaduct which carried the last uncut main line railway to Belgium and the Ardennes, during the fighting there in the spring of 1945. Ordinary bombs had been showered like hailstones at this bridge but had only chipped off bits of it.

The first grand slam bomb that was dropped just shook the masonry to pieces. It was a near miss, from an altitude of 15,000 ft., about 160 ft. to the north (Fig. 18). The subsoil was so badly shattered that it was thought hopeless to bridge the gap and the railway was diverted.

This paper described one method of making this somewhat unusual casting, but it should be mentioned that it has also been made successfully by more normal methods in another foundry in Scotland, and also in a foundry in the U.S.A.

It has also been made in the U.S.A. from a welded tube to which castings were welded to form the nose and base. Nevertheless, there is no doubt that if the job had to be started again little alteration in method would be made in the foundry whose work is described.

A sand slinger with a pattern draw machine would improve the molding, and some improvement might be made in the construction of the cage for the core. The cost of the core may be a little high, but that is more than offset by savings elsewhere, particularly in the dressing shop.

**Acknowledgment**

A special word of acknowledgment is due to Mr. C. A. Chaytor, Foundry Manager, Messrs. Whitehouse and Shepherd, Foundry Engineers, who were directly responsible for actual production and design of tools, for their assistance in preparing this paper.

The author is indebted to the R.A.F. for the action photographs, and to both the R.A.F. and the Directors of the English Steel Corp. Ltd. for permission to publish the paper.

## Carpenter Steel to Build New Laboratory

PLANNING LATEST and most complete facilities for development of new and improved steels and maintenance of exacting control over high quality tool, stainless and alloy steels, Carpenter Steel Co., Reading, Pa., has announced breaking of ground for a new modern research laboratory.

# THE METALLURGICAL AND ENGINEERING STATUS of CAST IRONS

Dr. R. W. Lindsay
Assistant Prof. of Metallurgy
Pennsylvania State College,
State College, Pa.

CAST IRON may be defined as a ferrous product containing so much carbon that it is not malleable as cast. In addition to iron and carbon, cast irons contain appreciable amounts of silicon and small but important quantities of manganese, phosphorus and sulphur. Quite frequently such alloying elements as nickel, chromium, molybdenum, vanadium, copper, etc., are added to confer special properties.

Three recognized types of cast iron are classified by the appearance of their fractures—namely, white, mottled, and gray cast iron. This article is confined mainly to gray iron.

Cast iron is melted in the cupola, air furnace or electric furnace, or by duplex and triplex processes involving these types of furnaces. The charge may vary from 100 per cent steel to 100 per cent scrap cast iron, or mixtures of these with pig iron.

### Three Heating Methods Used

Heat necessary to melt and superheat the charge may be furnished by the burning of coke, as in the cupola, by the burning of powdered coal, as in the air furnace, or by use of electric current, as in the electric arc furnace. Fluxes are used to slag off impurities, or slags may be formed for specific purposes such as oxidation or reduction of the charge in the electric furnace.

It is interesting to note that the first cupola was used in this country in Pennsylvania, in 1820. From this beginning the cast iron industry has developed tremendously in scope. It is estimated that 15,000,000 tons of iron castings are made annually in the United States, with some foundries making as much as 2,000 tons of castings daily. In addition, the estimated capacity of the malleable industry is about 1,000,000 tons annually, making in all a total of some sixteen million tons.

Unfortunately, cast iron has been treated somewhat like a step-child in spite of this enormous production, a fact that can be laid to several circumstances. First of all, in the past the cast iron producer has lagged while the application of metallurigal knowledge was making rapid strides possible in other fields.

Naturally, the chief result of this lack of foresight was a loss of business to processes competing with the casting industry. In recent years the industry has been keenly aware of this competition and generally has taken a more favorable attitude toward research and development work.

On the other hand, education in the metallurgical and engineering fields has not properly prepared graduates for the castings field. The opportunities in the field are overlooked and the properties and uses of cast iron are passed over rather hurriedly in the course of instruction.

**Application of metallurgical principles to cast iron production in recent years has resulted in improvement of the engineering qualities of the materials.**

The purpose of this article is to point out how the application of metallurgical principles has improved cast iron in recent years, and to emphasize some of the consequent improvements of the engineering qualities of the material.

### Has Wide Engineering Uses

A consideration of several applications of cast iron will serve to illustrate its importance as an engineering alloy. Automotive parts made of cast iron include cylinder blocks and heads, pistons, piston rings, cylinder liners, camshafts, crankshafts, and brake drums. The railroads use cast iron in the form of cast-iron car wheels, brake shoes, cylinders and pistons.

Beds and bases for machine tools are quite frequently manufactured from cast iron. Metal-working dies for such purposes as forming automobile bodies and fenders constitute another field for the use of these alloys. Cast iron rolls are used in rolling mills for shaping other metals and alloys. These applications by no means exhaust the fields of service for cast iron, but they do encompass most of the more exacting ones.

We may inquire as to what advantage cast irons possess for these uses. Naturally, one consideration is the ease with which it can be cast into complex shapes. The economy of the material is also prominently in its favor. However, it possesses some advantages which are even more important than these from the engineer's point of view.

It possesses excellent wear resistance, ranging from the abrasion

resistance of white iron to the non-seizing, good-wearing qualities of gray irons. This makes it valuable for uses ranging from railroad car wheels with a white-iron wearing surface to gray-iron piston rings and cylinder liners.

In addition, gray cast iron possesses a property known as damping capacity—the ability to absorb vibrations and prevent them from building up. This property is of value in machine tool setups and combined with low sensitivity to notches, the same property of cast iron offers interesting possibilities in its use as crankshafts and camshafts.

Other properties of cast iron which favor its use include its response to the same heat treatments as steel, and the fact that it is receptive to electroplating and chemical surface treatments.

Having considered the good features of cast iron, we shall now examine its disadvantages. These involve its rather low tensile strength and lack of a truly defined yield point and modulus of elasticity, together with a lack of toughness. However, the day of extremely low tensile strengths is past, and industrial production of irons with strengths of 60,000 psi. has been reported. Cast irons have been treated experimentally by combinations of alloying and heat treatment to produce tensile strengths of 100,000 psi.

The rigidity of cast irons has increased simultaneously with these increases in tensile strength. Although toughness has been increased to some extent, it remains low. A successful method for overcoming this objection wil be discussed in a subsequent section.

### Control Strongly Emphasized

Although the use of the air furnace and the electric furnace has increased in recent years, the cupola has remained the most widely employed melting unit. The developments in the melting process have been in several different directions.

The cast iron metallurgists have realized that it is necessary to exert a close control on the materials charged into the furnace in order to obtain best results. Control has now extended to control of the blast. It is important to control and maintain a constant weight of oxygen entering the cupola in order to obtain uniformity in temperature and metal quality. Three controlling mechanisms are now on the market for accomplishing this.

In addition, in certain phases of the industry it is important to control the quantity of moisture in the blast. Moisture control is especially important in piston ring manufacture, where the effect of blast humidity is accentuated by rapid cooling rates in the castings and frequently results in hard spots, making machining difficult or impossible. Use of pre-heated blast is now rather common and appears to offer definite savings in coke consumption.

### Ladle Additions

Another important development in connection with the production of cast iron is the use of ladle additions. This has been termed, rather aptly, "ladle metallurgy." Extremely small quantities of these ladle treatments have a pronounced effect on the final structures of cast irons.

Even though the melting process may be carefully controlled to tap out metal with optimum temperature and quality, it is still possible to spoil this metal in the casting process. In addition to proper planning of the mold to feed the casting adequately during solidification, it is necessary to condition properly the sand used for the mold so as to insure a good casting.

Thus the foundry metallurgist is interested in such properties of molding sands as moisture content, green and dry strengths, permeability and flowability, and the blending of sands to obtain the desired properties. The latest control methods in this respect cover evaluations of sands based on the properties at temperatures in the neighborhood of 1500 to 2500° F., in line with the temperatures to which the sands may be subjected when in contact with the molten metal in the mold.

In the final analysis, the properties of cast iron are determined by its internal structure, and the most rapid advances in our knowledge of this structure have been made in the last few years by the use of the microscope, thermal analysis, and testing of the properties by various methods.

It is now apparent that two factors must be controlled in gray cast iron in order to control the structure adequately: (1) the graphite flakes, the presence of which is responsible for the gray fracture; and (2) the metallic matrix or ferrous matrix. Cast iron has frequently been compared in its structure to a steel containing 0.80 per cent carbon, the main difference between the two being the presence of graphite in the former and its absence in the latter.

(1) *Control of the Graphite.* Control of the graphite involves the amount, size, shape, and distribution of the flakes. The amount of graphite present is directly related to the weight percentage of carbon in the iron. To illustrate, if we maintain 0.70 per cent of the total carbon in the so-called combined form, then in an iron containing 3.25 per cent total carbon, 2.55 per cent will exist as free or graphitic carbon; while in an iron containing 2.75 per cent total carbon, there will be 2.05 per cent present as graphite. The less graphite present, the less the steel-like matrix will be interrupted and hence, the higher the strength.

Size of graphite flakes will be controlled mainly by the cooling rate of the casting. Cooling rate, in turn, is related to the section size or wall thickness of the casting. Small or thin-walled castings will cool fairly rapidly and as a consequence, the graphite flake size will be small. Large castings that cool slowly will exhibit rather coarse flakes. Alloying elements have a secondary influence on size of the flakes.

### Control of Graphite Shape Argued

There seems to be a difference of opinion among metallurgists regarding control of the shape of flake. Some believe the shape is controllable by the use of alloying elements, while others are of the opinion that the shape of the graphite as it separates from the molten state cannot be varied.

A fine flake size is to be preferred to a coarse size because the former affects the continuity of the steel-like matrix less adversely. However, the distribution of the graphite also should be given consideration.

Fine flake size in poor distribution is actually detrimental. By the term "poor distribution" the author means such arrangements of graphite (which possesses no strength in itself) that lead to continuous lines of weakness through the structure. These arrangements of graphite are

known as dendritic, eutectiform, or grain boundary graphite, and are rather prevalent in the lower total carbon irons.

It has been found that poor graphite distribution can be eliminated through ladle treatments. By use of ladle treatments containing silicon (ferrosilicon, nickel, silicide, calcium silicide, and chrome-silicon-manganese) the iron can be made to solidify in such a manner that the graphite precipitates from the molten condition in a good (random) distribution, thus eliminating the weakening effect.

(2) *Control of the Steel-Like Matrix.* The other structural factor to be controlled is the ferrous matrix. The aim in a good cast iron is to balance composition and cooling rate in such a way that the ferrous matrix consists entirely of the micro-constituent known as pearlite.

An entirely pearlitic structure in steel is obtained with a carbon content of about 0.80 per cent. In cast irons, a pearlitic matrix may be found with a combined carbon content of 0.60 to 0.80 per cent, depending on other factors. The combined carbon content is governed by cooling rate and composition. A slow cooling rate leads to a soft, weak iron, while a rapid cooling rate results in a hard, brittle iron.

An iron with a pearlitic matrix is to be preferred. Certain alloying elements (carbide-forming elements) will stabilize formation of a pearlitic matrix. Nickel is unique in that it causes any excess iron carbide (cementite) to graphitize but does not affect the iron carbide in the pearlite and hence stabilizes the pearlitic matrix.

### Iron Widely Heat Treated

Since the matrix of cast iron is similar to that of steel, it would be expected that cast iron might respond in similar fashion to heat treatment. This is actually the case, although the full possibilities of the heat treatment of cast iron have not been realized as yet.

Two types of heat treatment are employed to improve cast iron . . . a stress-relief annealing operation, and a hardening and tempering treatment. This disregards the softening anneal practiced at times to eliminate hard corners or edges on castings.

The purpose of the stress-relief anneal is to remove stresses set up in the casting as it solidifies and cools. Such stresses, if allowed to remain in the casting, will cause distortion and at times even breakage of the article. Stresses are eliminated by annealing at temperatures up to 1000 or 1100° F., the top annealing temperature being limited by the stability of the pearlite. Temperatures should not be carried so high as to cause deterioration of this type of matrix.

The hardening and tempering heat treatment is performed for the purpose of strengthening and hardening cast iron. Several of the precautions observed in the quenching of steel apply also to cast iron. Flame hardening has been applied to cast iron, especially in the machine tool field, for hardening of localized areas.

### Pearlitic Malleable Developed

This is an interesting and more or less recent development in the industry. White cast iron is the base alloy for this product and is put through a malleableizing anneal to produce pearlitic malleable irons. The carbon in white iron is totally in the combined form and no flake graphite is present; in fact, the presence of more than a trace of the latter is detrimental.

The white iron is malleableized at temperatures sufficiently high (about 1600° F.) to break down the excess iron carbide according to the following equation:

$Fe_3C \rightarrow {}_3Fe + C$

Iron

Carbide → Iron + Carbon (Graphite precipitate).

Graphite formed by this treatment is nodular or spheroidal, as compared with the flake type of graphite formed during the solidification of gray cast irons.

The partly malleableized iron is cooled rapidly enough to retain a certain portion of combined carbon as a pearlitic matrix. As with steels and gray cast irons, the structure of this matrix can be regulated by heat treatment.

Again we note a similarity to steel. Furthermore, the continuity of the steel-like matrix is better than in gray cast iron because the nodular type of graphite is less effective than the flake type in destroying this continuity. Hence, these irons are rather tough, possess some ductility, and are fairly strong. In addition, they maintain some of the characteristics of gray cast iron, as for example good wear resistance.

The pearlitic malleable irons have replaced certain steels in some applications such as automobile camshafts, valve rocker arms, and connecting rods, and are used for other parts such as pistons, crankshafts, shifter forks, and gears. Advantages are claimed for this material in applications requiring shock and fatigue resistance with high strength, at the same time retaining good casting ability, machinability, and good wearing qualities.

The foregoing has been an attempt to point the directions being taken in research and development work on cast iron. Although certain beneficial refinements have been made in the melting process, the bulk of cast iron tonnage still is produced in the cupola, first introduced into this country in 1820.

Most of the steady advancement in improvement of this material has resulted from study of its internal structure and from manipulations of this structure based upon these studies. This manipulation starts with the melting process by control of composition, temperature and treatments in the ladle, and continues in the solid state by use of heat treatment to improve the properties of the steel-like matrix.

The result is the development of properties of cast iron to levels regarded as out of the question not so long ago, and the application of these improved cast irons to uses where formerly it was not considered at all.

### Cast Iron Applications

The engineer should realize the advances that have been made and consider further possible applications for the material. In such considerations he should realize the limitations of cast iron and should seek advice from shop men so as to best adapt the design of the part to the molding and casting processes.

In turn, he has the right to expect the metallurgist to maintain a uniformity of product, preferably at a high level, so that he is sure of consistent quality and performance.. Besides a maintenance of control over quality, the metallurgist's training

should be such that he can apply sound metallurgical principles to the problem of further development of properties already established as inherent in cast irons.

A spirit of co-operation should exist between the metallurgist and the engineer and their respective training should be such that each is acquainted to some extent with the other's terminology and problems. When this is the case, further advancements will be possible in the industry.

# FOREIGN VISITATION

## *Extremely Large at A.F.A. Convention*

ONE OF THE many outstanding features of the Golden Jubilee Foundry Congress and Foundry Show was the multitude of foreign visitors that attended the technical sessions, viewed the exhibits and took part in the plant visitation tours. These men made an earnest effort, through discussions with American foundrymen, to learn as much as possible of American methods and practices for producing ferrous and non-ferrous castings.

A total of 133 foreign foundrymen, representing 17 foreign lands, registered during the period May 6-10. Taking into consideration that this was not an International Foundry Congress, the foreign representation was surprisingly large.

The list of foreign visitors (up to the time this issue of the magazine had gone to press) is shown below.

**Argentina**

Ronald H. Alcock, Plant Supt., Ferrum, Buenos Aires.

**Australia**

Arthur Charles Waters, Man. Director, Hadfield Steel Works, Ltd., Alexandria, Sydney.

**Belgium**

Gerad Lamoureaux, Asst. Mgr., Usines Henricot Court SN Etieme.

M. Remy, Administrateur, Herstac-Belgium.

**Brazil**

Mauricio Grinberco, Cia Brazileira de Material Ferroviario, Sao Paulo.

Joad Gustavo Haenel, Eng. Met. Dept., Inst. of Pesquisas Tech., 110 Prhea Coronel Fernando Prest., Sao Paulo.

R. B Harrison, Gen. Agent, Microtecnica Ltda.

F. J. Larrabure, Cia Brazileira de Material Ferroviario, Sao Paulo.

Manuel O. A. Morses, Engineer, Inst. de Pesquisas Tech., Sao Paulo.

Mauricio Noirusky, Cia Brazileira de Material Ferroviario, Sao Paulo.

Mauricio Novinsky, Engr., Cia Brazileira de Material Ferroviario, Sao Paulo.

S. T. Reinosa.

Mauricio Zrinbert, Brazilian Railroad Equipment.

**China**

Che-Tyan Chang, Chinese Air Force.

K. A. Chang, Senior Engr., Unnan Iron & Steel Works, Unnan.

Steven C. Chang, Engr., Central Electric Works of China.

T. H. Chang, Mech. Engr., National Resources Commission of China.

Yeh Chang, Engr., N. R. C. of China, Nanking.

Pen Chen Han, Engr., Chinese Supply Commission.

Tai Chen, Engr., N. R. C. of China.

Wang Si Chi, Engr., Chinese Government.

P. C. Chin, Architect, Directorate General of Posts, Nanking.

Tai Chi-Ngong, Architect, Ministry of Communication, Nanking.

Yung-Sheng Chow, Engr., Central Machine Works.

C. C. Chow, Asst. Chief Engr., China Electric Steel Works.

Pao-San Chu, Engr., N. R. C. of China, Nanking.

William Dih, Mech. Engr., National Resources Commission of China.

T. P. Feng, U. S. Repr., Asiatic Overseas Co., Shanghai.

Kuei-Feu Hsuan, National Resources Commission of China.

M. S. Huang, Engr., Chinese Air Force.

Y. W. King, Chief Chemist, Chinese Ministry of Communications, Nanking.

Ke-Cheng Koo, Asst. Engr., Central Machine Works of China.

Hsia, I-Kun, Engr., N. R. C., Iron & Steel Works of China, Kunming.

Shan-Chi Kung, Engr., N. R. C., Chungking.

Ke-jen Kuo, Engr., National Resources Commission of China.

Wei Liang Lee, Engr., Chinese National Res. Comm., Nanking.

Lee Kwok-Leung, Foundry Engr., The China Automotive Co., Chungking.

Hsia Wei Lin, Engineer, Chinese Director Gen. of Posts, Nanking.

Han-Fan Ling, Engr., National Resources Commission of China.

Hsiung Ling, Chinese Tech., Cleveland Diesel Engine Div.

Clinton Liu, Engr., Chinese Agr. Eng. Corp., Chungking.

Ya-Heng Loo, Mech. Engr., N. R. C. of China.

T. H. Peng, Met. Engr., Nat'l Central Automotive Parts Mfg. Works, Chungking.

Hsaio, Tsai-Li, Engr., Chinese Government.

S. L. Tung, Engr., Central Auto Parts Mfg. Works, Chungking.

Tze I. Sung, Engr., China Industrial Co., Chungking.

Lin-Siang Woo, Engr., Chinese Air Force.

Ching-Chang Yang, Met., National Resources Commission of China.

Sun Yun-Luan, Chinese Tech.

**Czechoslovakia**

Jan Hajsman, Gov. Official, Czechoslovak Government.

L. Jenicek, Official Delegate, Czechoslovak Foundrymen's Assn., Prague.

**Denmark**

Svenk Heineke, Pres., The Danish Association of Iron Foundries, Kerteminde Iron Foundry, Kerteminde.

**England**

George W. Bush, Director, Renshaw Foundry Ltd., Staines.

Charles William Coleman, 66 Norton Road, Letchworth.

J. Dearden, Met., L. M. S. Ry., Derby.

Vincent Delport, European Mgr., Penton Publishing Co., London.

W. J. Driscoll, Dev. Eng., British Cast Iron Res. Assn., Alvechurch, Birmingham.

Marjorie Davis Edwards, 66 Norton Road, Letchworth.

Basil Gray, English Steel Corp., Sheffield.

G. L. Hancock, Branch Mgr., David Brown & Sons, Ltd., Penistone N. Sheffield.

Alfred Jackson, Director, Gaxton & King Ltd., Tam Lane Exeter, Devonshire.

Thomas Lee, Director, Henry Hollingdrake & Son Ltd., Prince St., Stockport.

Tom Makemson, Secy., Institute of British Foundrymen, Manchester.

John Metzl, Cons. Chief Engr., Strebor Die Casting Co., Radcliffe.

Frank Wareing Nield, Chemist & Met., Henry Wallwork & Co., Ltd., Red Bank, Manchester.

E. Owen, Met., Walmsley's Ltd., Burry Lane.

H. A. Pearce, Director, British Cast Iron Research Assn., Alvechurch, Birmingham.

R. S. Pratt, Asst. Works Supt., P. R. Jackson & Co., Salford Rollins Mills, Manchester.

Maurice Riddighough, Tech. Mgr., Deloro Stiellvet Ltd., Birmingham.

W. F. Rowden, Director, Climax Molybdenum Co., 2-3 Crosby Square, London.

Michael Royce, Works Engr., Conegre Foundry Ltd., Tipton, Staffordshire.

F. E. Tibbenham, Foundry Mgr., Suffolk Iron Foundry Co. Ltd., Stowmarket.

**France**

R. Boutigny, Chief Engr., Stein & Roubaix, 24 we Eranger, Paris.

*(Concluded on Page 41)*

*Opposite page—General convention picture taken at the A.F.A. 50th Annual Convention.*


POWER FOR THE
19
50th
50th ANNIVERSARY BANQUET

# 50 YEARS PROGRESS IN

# FOUNDRY PIG IRON

**T. G. Johnston**
**Metallurgical Engineer**
**Republic Steel Corp.**
**Cleveland**

IRON MAKING, like other industrial processes, has undergone a spectacular period of transition in the past 50 years. Primarily this has been brought about because of the unprecedented development in the application of scientific methods to the study and examination of both the process and the product.

Results of this change can be recognized in the foundry in the availability today of quality irons suitable to the most exacting and various needs of the modern foundrymen. Iron making, from an art, has developed into a science.

Prior to 1890, except for a few unique instances, rule of thumb and trial and error methods predominated. Blast furnace operation and pig iron quality were nebulous factors, defined and confirmed simply by the recognized experience already familiar to either the producer or consumer.

### Controls Insufficient

Standards and specifications of both practice and product, where in existence, were lacking in realism and openly displayed an inadequacy for the job they claimed to do. Credulous doctrines, based upon some half forgotten lore which had persisted in some instances from the time of the finest hand forges of medieval ironmasters, contradicted as often as not rules of logic and understanding which subsequently had been developed.

Some there were who questioned and searched, but more often than not their theories were laughed at or denied; the sciences of chemistry and of metallurgy were suspect and chemists and metallurgists were cast in the roles of practitioners of witchcraft.

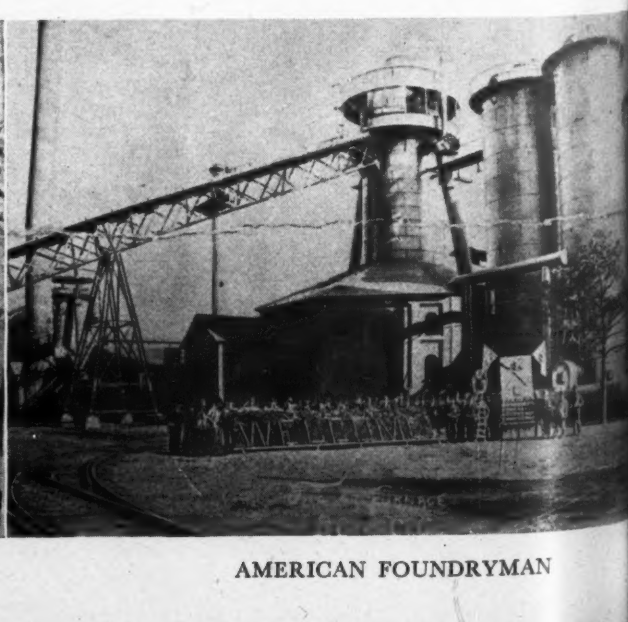
If, in this present age, we still have to purge ourselves of the vestigial forms of this sorcery of darkness and misunderstanding, we at least carry more assurance, from the progress of the past half century, that we are well upon the path to enlightenment. The extent of this advance, compared with that of the previous 300 years, is too obvious to dispute.

### Early Developments

Many improvements were first introduced just prior to the turn of the century. Hot blast was first introduced in 1834, followed by the use of waste gas for steam. Then important developments were made in the fuel used. The use of bitumi-

*Fig. 1—Furnace built in 1834. Capacity, 1 ton per day.*

*Fig. 2—Furnace of 1895—200 tons per day.*



nous coal was followed by anthracite coal, which was used as a mixture with the former. Its use separately as fuel exceeded the use of charcoal in 1855. Experiments were also started in the production of coke in beehive ovens. This production increased, and by 1850 coke had become well established as a blast furnace fuel.

### Alloy Sensitivity

With the changes in furnace construction, improvements in operation and metallurgical control, the blast furnace operator is able to produce iron within the specified range of various elements, which made it possible to grade in 25-point ranges for silicon and manganese and close limit for phosphorus. Also, to eliminate alloys where necessary, and when required they can be added by selection of raw materials for the furnace burden.

Beehive ovens were replaced by by-product ovens, with considerable saving in coal and improvement in the quality of coke. The building of furnaces at new locations more convenient to markets also resulted.

### Improved Production

With improvements in furnace construction and methods of operation, tonnages were increased and the number of furnaces decreased. While records as to the number of furnaces are not available, tonnages increased from 798,515 tons in 1856 to 5,683,329 tons in 1886, and 39,434,797 tons in 1916. In 1944 tonnage was increased to 61,007,439

*Fig. 6 (above)—Sand-cast pig iron. Note heavy runners and scruffy surface clearly evident in photograph.*

*Fig. 5—Sand-cast pig iron. Note broken pieces from one car of iron.*

*Fig. 3—Same furnace shown in Fig. 2 rebuilt and in use in 1946. Capacity, 500 tons per day.*

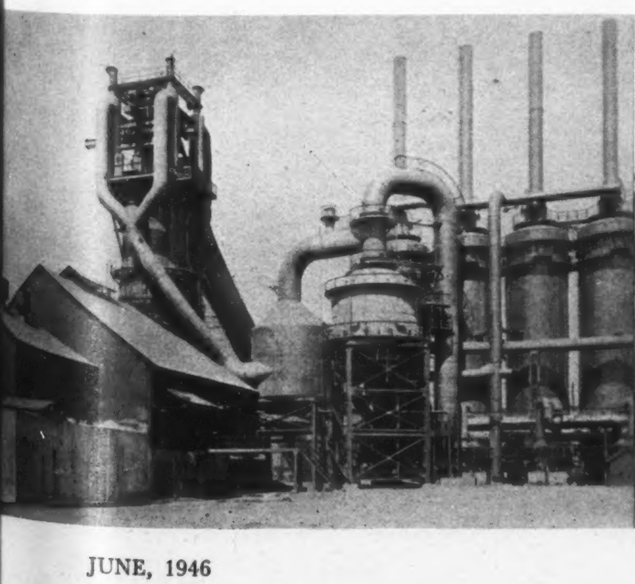


*Fig. 4 (below)—Sand-cast pig iron showing variation in size and weight of pigs.*

*Fig. 7—Iron, irregular in size, cast in chill molds (type used in 1900).*

tons, this being the largest production on record, and 53,454,872 tons were produced in 1945 (Figs. 1, 2 and 3).

Progress which we can claim for modern foundry iron must of necessity spring from the improvements made in blast furnace practice and operation.

#### Furnace Design

During the past 50 years the blast furnace has, indeed, felt the press of evolution. The process which we have today is based largely upon the findings and experience of that period. For one thing, the chemists and the metallurgists have been able to approach the study of the blast furnace and its operation upon purely scientific lines.

Applying physical and chemical laws to the process of iron ore smelting, furnace lines have been modified to synthesize more nearly the ideal state for the reduction process, approximate more closely the requirements of the raw materials for reduction, and bring closer to perfection the final product.

#### Melt Components

Raw materials — iron ore, coke and limestone—also have been subjected to study and modification to produce a more perfect form of material, permitting of a more economical and better product. Classification, concentration and beneficiation of ores has developed into a science in itself, contributing to a solution of many of the problems of ore reduction.

Studies directed to the development of an ideal blast furnace coke have grown tremendously in importance and scope, and even limestone, although not so vital to the blast furnace process, has served as the subject of intensive investigations. Mining, blending, crushing and sizing, too, have progressed, and one cannot forget the scientific concern lavished on air, the greatest raw material (in bulk), utilized in reduction in the blast furnace.

These, and the countless other investigations and research projects which have flourished and borne fruit in the past half century, should be the immediate concern of all foundrymen, for these are the things through which he profits. These activities give him the superior raw material — pig iron — which he demands for his superior product—iron castings.

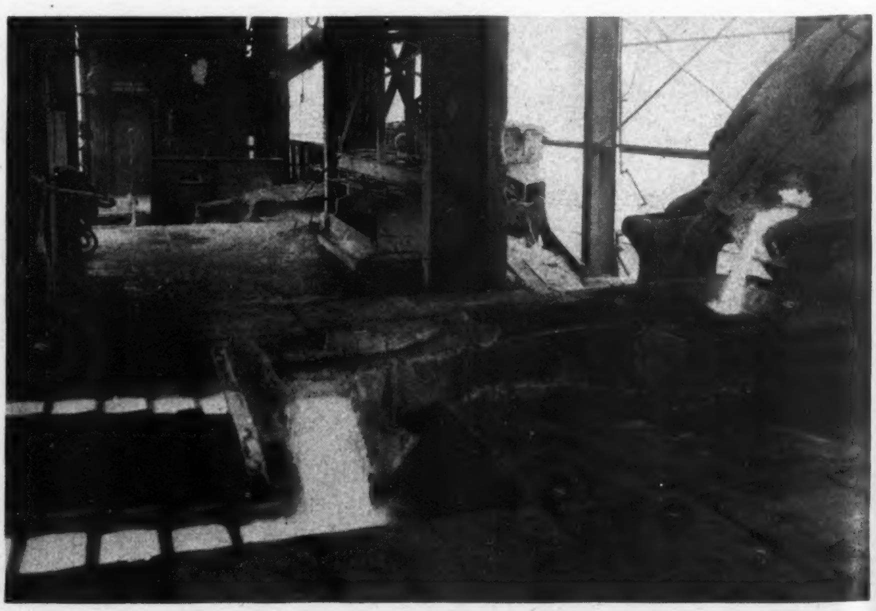
#### Cost Reductions

Supplementary to the developments in iron reduction, other changes in the blast furnace have left their mark upon the foundry. As the science of ironmaking progressed, furnaces grew larger and iron casts became greater, chill beds, consisting of huge permanent molds, were introduced in place of the sand pig beds which had become both inadequate and uneconomical. Since the chill beds could be used over and over again, the high labor costs of the sand molds were reduced.

Pig breakers also were devised, dispensing with the back-breaking task of breaking the pigs free from sows and runners (Figs. 4 and 5).

Other modifications of the chill bed were tried. One, in particular, consisted of a revolving table carrying molds from which solidified pigs could be removed and the molds refilled during the completion of a revolution. The latest stage in the casting of pigs, as we see it today, is the modern pig machine—first in-

*Fig. 8—Modern method pig casting machine. Note method of skimming metal entering molds, and large ladle for mixing all metal from one cast.*



stalled in the year 1896—where endless belts of molds receive predetermined amounts of molten iron and deliver cooled pigs into railroad cars ready for shipment (Figs. 6 and 7).

Peculiarly enough, the loudest protests to this innovation in the manufacture of pig iron came from the foundrymen. They had a reason, although, as events proved, it was not a valid one. This reason was that the new procedure interfered with the time-honored method of grading iron by fracture.

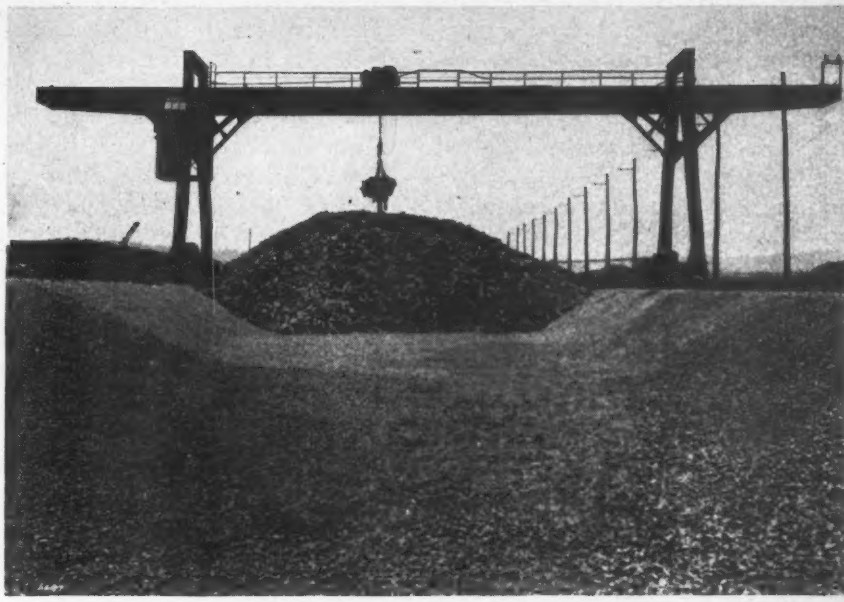


*Fig. 10—Present method of stocking and handling iron for shipment.*

### Grading System

In this grading system the large, grainy structure of the pig iron, as cast in the sand bed, was utilized to differentiate between various grades of iron. An elaborate system of grades had been established to standardize the types of iron according to how they looked when fractured. The casting of molten iron into chill molds rendered this standard null and void, since it was found that chilled pigs no longer had a large, open structure, but were fine grained.

Since chemical analysis had not yet become respected nor accepted criteria of iron quality, the foundryman who was accustomed to fracture grading was wary of the product of the pig machine. It was many years before he finally overcame his almost superstitious dread of the clean and uniform machine-cast pig and the scientific chemical analysis of the metal thus produced.

This attitude persisted in spite of the innumerable benefits which were thrown the foundryman's way. His pride and joy, the sand-cast pig, was not uniform in size, nor were the pigs from the same cast uniform in composition. Considerable wastage occurred from pieces spalling off during the handling.

Furthermore, the accepted practice of the blast furnaceman was to cover the solidifying pig with loose sand to slow the cooling period and to protect the workmen in the cast house from the intense heat. The result was that the foundryman usually purchased a quantity of sand (computed at about 224 lb. per ton) at pig iron prices. This adhering sand, aside from the high original purchase price, cut further into the foundry's profits in that more fuel and more flux were required to melt these pigs in the cupola.

*Fig. 9—Pig iron from modern casting machine. Note cleanliness of surface of iron and uniformity in size.*

### Analysis Variation

Moreover, with the sand-cast pig graded by fracture, the foundryman had little assurance, if any, of the elements and their amounts in his iron or in his final product. The analysis often would vary as much as one per cent in silicon content from the beginning to the end of the same cast.

On the other hand, the benefits the foundryman gained from the machine-cast pig were numerous. He bought a clean and uniform pig that was easily handled and stored, because the pig machine required that iron be first cast in a ladle and then poured through a runner into the moving molds. By this method all of the iron from one cast was mixed in one large ladle, and when poured was skimmed before entering the molds, resulting in a more uniform analysis of cast. In the absence of adhering sand, the amount of impurities going into the cupola required less flux, and less slag was formed by the use of chill-cast iron (Fig. 8).

In computing the mix, the uniform size and weight of this iron

made cupola charging much more accurate, whether the charge was weighed or the number of pigs estimated for a charge (Figs. 9 and 10).

The foundryman soon recognized the necessity of computing his mixes and charges upon the chemical analysis of his iron. In a sense, this one item, the introduction of the chill mold by the blast furnace, is responsible for much of the present state of foundry practice. Whereas, before its advent, standards and specifications for pig iron existed, they were of a dubious nature.

Fracture grading was the work of an expert. Upon his decision of how iron looked upon breaking rested the ultimate value of a cupola charge.

Without question, fracture grading served the purpose, and, with the aid of an expert, served it well. However, as we know today, such practices are inadeqate for both volume and specialized production.

### Standards Improved

The chill-cast pig, with its homogeneous and close-grained structure, was probably the one item more than any other which caused the acceptance of the unequivocal chemical analysis. Upon its adoption, standard specifications and sampling methods were developed to meet this crisis of the cupola and so eliminate much of the guesswork of the foundry.

We have not reached the ultimate by any means. Sick furnaces and other causes still persist, upon occasion, in producing off-grade iron and in upsetting the uniformity of composition.

Within narrower and more specified limits is a goal still to be reached. Headaches persist in both the foundry and the blast furnace. Yet, during the past 50 years, we have seen iron production double and redouble in both quantity and quality. We have seen iron castings assume a station which our predecessors would have believed impossible.

But the fight is not over. The depletion of our better natural resources has gone forward, especially during the past 5 years, at a staggering rate. Yet even as the spectre of inferior raw materials begins to face us, the foundryman and the blast furnaceman recognize that this will not slacken the constant insistence upon quality and economy. They know that it is up to them, even with inferior materials, to make a better product. Knowing this, they have only to glance backward along the path they have come, to regain their confidence in the future. The progress that has been made is assurance of progress still in making.

## Instrument Conference Planned for September

With attendance of more than 1500 expected and space already reserved for exhibits of 80 manufacturers, Instrument Society of America, Pittsburgh, Pa., will hold its First National Instrument Conference and Exhibit at the William Penn Hotel, Pittsburgh, Sept. 16-20, Richard Rimbach, executive secretary of the Society, has announced.

New and improved instruments and controls perfected during the war are expected to be on display; and a program of 15 sessions has been arranged. Some of the subjects included will be: Measurement and Automatic Control in Industry, Plant Instrument Department Practices, Inspection and Gaging, Scientific Measurements, Research in Instrumentation and Physical Testing.

## Large Castings Are Produced at United

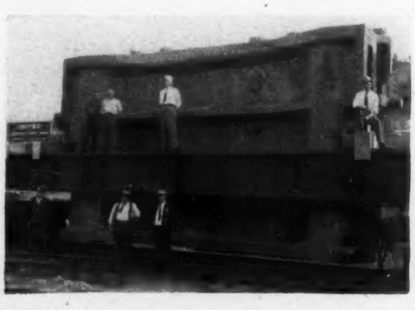
In the construction of two giant presses—perhaps the world's largest—for the Navy, United Engineering & Foundry Co., Youngstown, Ohio, produced castings so large and heavy that their shipment presented unique problems to the railroad.

In the case of one of the presses, a straight hydraulic unit operated by water at 4,500 psi., ten steel castings weighing from 150 to 170 tons comprise the main members. Some of these components, such as the press cylinder which weighed 317,380 lb., were shipped on 250-ton, 16-wheel flat cars.

However, the entablature side frames were of dimensions too large for ordinary clearances, and weighed 322,780 lb. Two 65-ft. girders resting on bridge ends mounted on center plates, formed a bridge between two 250-ton flat cars; and the piece was hung between them. In a like manner sections of the crosshead, weighing 339,820 lb., were transported.

Special trains, restricted to 10 mph., carried these castings.

*One of huge castings produced for Navy. Note girders (which rest on bridge ends mounted on flat cars) supporting component, ready for shipment by special train.*



## Industrial Safety Posters Available

Industrial safety posters for plant display and use in safety training courses have been made available by the U. S. Department of Labor. Depicting work hazards and dangerous work practices, the posters also show how to work safely.

Subjects available include circular saws, power trucks, band saws, grinding wheels, ladders, gas welding and cutting, hand trucks, hammers, arc welding equipment, low voltage electric equipment, screw drivers, drill presses, punch presses, engine lathes, shapers and wrenches. To be released monthly during the remainder of 1946 are posters on traveling cranes, scaffolds, metal shears and brakes, freight elevators, cold chisels, electrical hazards, compressed air cylinders, and jointers and planers.

The posters are 11 inches wide and 43 inches long, and are printed in black and red on white paper. Privately prepared in collaboration with the Division of Labor Standards, copyright restrictions have been waived permitting the posters to be reproduced and used in any way which will promote safety for workers.

Industrial safety posters can be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Remittance of five cents per copy or $3.75 per hundred copies should accompany the order.

## Foreign Visitation

*(Continued from Page 34)*

F. A. Boyer, Stein & Roubaix, Paris.
M. Cherbuy, Automobile Peugeot, Scchaux (Doubs).
Francois A. Choffel, Ingersoll Rand Co., Paris.
Hubert M. Cromback, Pres., Fonderies Cromback S. A., Paris.
Maurice Cuni, French Government Repr., French Supply Council.
Marcel Debrock, Tech. Director, Codari et Dubru, Goissy.
Emile Dewez, Engr., S. A. A. Citroen, Paris.
Jena Dignac, Engr., S. A. A. Citroen, Paris.
Robert Durevil, Mgr., Aeromecanique, 4 Square du Grainivaudan, Paris.
Edouard Dussourd, Bonvillain et Ronceray, Rue Paul Carle, Choisy le Roi.
Mr. Gallais, French Government Repr., French Supply Council.
Robert Grimault, Ing. Fenwick, S.A., Paris.
Marcel Jaumain, C des Mones Fonderies et Forges d'Alais, Tammaris-Allisard.
Mr. Laine, French Government Repr., French Supply Council.
F. Modro, Fdry. Mgr., Stein & Roubaix Co., Paris.
R. Ronceray, Pres., Ph. Bonvillain & S. Ronceray, Choisy le Roni.

#### Holland

J. G. Hofman, Metal Bedrufrademakers NV, Schaarduk 145, Rotterdam.
J. H. Ubbink, Managing Director, N. V. B. Urbins & Co., Doesburg.

#### Mexico

Juan Codina, Engr., Mgr., Cowen S de R.L. Sabino 380, Mexico City.
Santos Letona, Owner, Fundicion el Rosario, Puebla.
Manuel Schwartsman, Sde Mayo 10 desp. 8.
Rafael Ortega Varela, Engr., Commission Federal Electrical, Villa Obregon.

#### Norway

J. Gorrison, Director of Research, Christiania Spigerveik, Oslo.
J. Sissener, Cons. Engr., Myrens, M. V. Oslo.
Carl Edward Torp, Met., Christiania Spigerverk, Box 324, Oslo.

#### Russia

I. S. Antimonov, Engr., Soviet Purch. Commission.
V. I. Barykin, Engr., Soviet Purch. Commission.
D. Butakov, Insp., Soviet Purch. Commission.
A. Freidlin, Purch. Engr., Soviet Purchasing Commission.
Vladimiz Glushkov, Engr., Soviet Purch. Commission.
K. P. Ivanov, Engr., Soviet Purch. Commission.
V. S. Kharitonov, Soviet Purch. Commission.
A. G. Krylov, Engr., U.S.S.R.
G. Martirossov, Engr., U.S.S.R.
N. G. Mozokhin, Engr., Soviet Purchasing Commission.
N. Neskorodiev, Engr., U.S.S.R.
Boris G. Pavlov, Engr., Sov. Purchasing Commission.
A. Romanova, Engr., U.S.S.R.
Yvig Shvacaturo, Insp., U.S.S.R.
A. Ryzhikov, Engr., U.S.S.R.
Anatoli A. Zhitkov, Engr., Soviet Purchasing Commission.

#### Scotland

P. W. Lygo, Tool Draughtsman, Vactric Ltd., Airdrie.
D. W. L. Menzies, Managing Director, North British Steel Foundry, Bathgate.
Tom Shanks, Works Director, Cruikshank & Co., Ltd., Denny Iron Works, Denny.

#### South Africa

D. Kenealy, Managing Director, Armco (Propietary) Ltd., Johannesburgh.
Peter West, Director, Vitreous Enameling Corp., Capetown.

#### Sweden

S. Alexanderson, Chief Engr., Wedaverhen, Sodertalje.
T. Forslund, Asst. Works Mgr., A. B. Swenska Kullagerfabriken, Katrineholm.
Yngve E. Frid, Akers Styckebruk.
A. Huldt, Mgr. & Gen. Supt. the Foundries, Domnarfuet Iron & Steel Works, Comnarvet.
Thomas Lewander, Sales Mgr., Hugo Montgomery, Stockholm.
Sten Linander, Linhamns Aduceringsverk, Limhamn, Malmo.
Erik O. Lissell, Dir. of Res., Swedish Ass'n of Mach. Shops and Foundries, (Mekonforbundet) Stockholm.
Shg. Hjson Ljunggren, Foundry Mgr., Kohlswa Steel Works, Kolsva.
Hengt Magnusson, Director of Res., Husgvarna Vapentabr RSAB, Huskvarna.
Herman Pyk, V. P. & Tech. Dir., A/B Atlas Diesel, Stockholm.
Hans Rudberg, Asst. Director, Akfiebelaget Jarrforadling, Halleforshas.
Nils G. V. Svensson, Mgr., (Chief Engr.) A. B. Gjuterimaskiner, Halmstad.
Kjell Von Scheele, Prod Mgr., Husgrarna Vapentabr R S A B, Huskvarna.

#### Switzerland

Max Christen, Max Christen, Inc., Basley.

## Announce Industrial Betatron Machines

COMMERCIAL MODELS of the Betatron, which generates x-rays of twenty million volts, are ready for use in industry, G. D. Adams, Jr., physics department, University of Illinois, Urbana, stated recently before a radiography symposium sponsored by Marquette University, Milwaukee.

Arranged for simple operation requiring a minimum of instruction, the commercial unit occupies a space only 5-ft. long by 3-ft. high and 2-ft. thick.

#### Invented by Kerst

The Betatron, an invention of Prof. D. W. Kerst, University of Illinois, was developed secretly during the war; and operates on the principle of accelerating the speed of electrons in a circular vacuum tube to a velocity approaching that

*The camera of John Bing, A. P. Green Fire Brick Co., Milwaukee, was kept busy during the 50th Annual Convention and these pictures are some he forwarded to the National Office.*

*Photograph taken from the lower level of Lakeside Hall showing a few of the many exhibits on that floor. In the background can be seen the upper level, Lakeside Hall.*

of light, through use of magnetic fields.

Hurled from a pin-point source, the beam of electrons is said to equal in intensity the radiation of approximately 5,000 grams of radium. Rays will penetrate 20-in. of steel and produce a satisfactory exposure in 1½-hr., according to report; will reveal flaws as small as 1/32-in.; and magnifies images to three times actual size.

# FOUNDRY SCIENCE

## *Developments Spur Future of Magnesium*

REFERRING TO recent advances in foundry technology, among other factors, J. C. DeHaven, Battelle Memorial Institute, Columbus, Ohio, indicated a new era of applications in prospect for magnesium, as he discussed "The Development of Magnesium Alloys as Aircraft Materials" before the recent National Aeronautic Meeting of the Society of Automotive Engineers, in New York.

Commercial production of low-impurity castings may soon be feasible as a result of improved techniques, Mr. DeHaven noted; which would make possible use of alloys containing low amounts of zinc. The latter type of alloys, the speaker pointed out, have better feeding characteristics, require fewer risers and are easier to heat treat than higher zinc alloys. Production costs should also be reduced as a result of the late developments, it was noted; and this factor, together with higher yield possible with low-zinc alloys, should make available for the future, cheaper, more corrosion-resistant magnesium castings of high quality.

Mr. DeHaven is a member of the A.F.A. and has presented a number of papers on magnesium before technical meetings and regional conferences. Many of his papers have been published in AMERICAN FOUNDRYMAN.

He is a member of the Centrifugal Casting and Shrinkage and Porosity committees, A.F.A. Aluminum and Magnesium Division.

## Foundry Safety Record

DEMONSTRATING that the foundry is a safe place to work, several A.F.A. company members in the Twin City A.F.A. chapter have won safety awards from the Minnesota Safety Council, which held its Annual Meeting at the Nicollet Hotel, Minneapolis, April 10.

At the meeting, Governor E. J. Thye, of Minnesota, presented Continuation Certificate Awards to: Flour City Ornamental Iron Co.; General Mills, Inc.; Minneapolis Electric Steel Castings Co.; Minneapolis-Moline Power Implement Co.; Northern Ordnance Co.; C. W. Olson Mfg. Co.; and Paul Pufahl & Son Foundry Co., all of Minneapolis.

### Can You Help?

A.F.A. is anxious to obtain some copies of A.F.A. TRANSACTIONS, Volume 52 (1944) from members who may have no use for copies in their files. The supply of this volume is entirely exhausted and a number of important requests have been received for this edition.

For intact copies in good condition A.F.A. will be glad to make arrangements for purchase. If you have a copy of Volume 52 which you do not need, please forward promptly to: The Secretary, American Foundrymen's Ass'n, 222 West Adams Street, Chicago 6, Ill.

*Architect's conception of contemplated new engine factory of Caterpillar Tractor Co., Peoria, Ill. Plant will be modern in every detail, incorporating air cleaning and ventilating features as well as latest developments in factory lighting.*

# MAGNESIUM ALLOY CASTINGS

## Relative Significance of Design and Metallurgical Factors to Serviceability

George H. Found
Dow Chemical Co.
Midland, Mich.

MODERN DEMANDS for efficiently designed, light-weight parts for mobile or reciprocating structures has prompted the extensive use of magnesium alloys for such purposes. The uses to which these structural parts are put almost invariably involve cyclically alternating stresses which are impressed on these parts throughout their normal service life. For this reason, the service performance of light metal castings is frequently governed by the fatigue properties of the castings.

### Stress Reduction

In parts where incidental parasitic or sympathetic vibrations exist which lead to fatgue failure, it often is possible to improve service life by reducing the magnitude of cyclic loading. Frequently, this is accomplished by stiffening various structural parts with brackets and stiffeners or by the use of generally more rigid structures.

In cases where the intended functions of the parts involve working stresses of the cyclic type, such as in aircraft wheels, fans, propellers, and certain engine castings, it often is impractical to consider reducing the magnitude of these cyclic loadings.

For this reason, an approach to the problem of improving service performance from the aspect of increasing the resistance of the parts to fatigue failure, rather than from the aspect of reducing the amount of such stressing, greatly assists the application engineer.

A study of the criteria and practices used for selecting and using materials for structural applications, as well as a study of the parts themselves and their service performance, shows that several factors contribute to precipitating failure by fatigue in light metal parts.

Structures of the type made of magnesium or aluminum alloys usually are intended to operate at high structural efficiency. This means that all of the material in the part would be contributing efficiently to the load-carrying ability of the structure.

When such is the case, the working stresses usually are considerable throughout much of the structure, especially with respect to the fatigue strength of the structural material.

Major attention in selecting materials and in design usually is based upon the static strength properties of materials and not as often upon their fatigue properties. Reliable information for the latter has not been as generally available for the the static properties.

This difficulty is being relieved by the recent additions of information from laboratory fatigue tests on magnesium alloys*. These additions include advice regarding the most effective use of these data.

### Design Aspects

Since the nominal strength of parts usually is dependent upon their shape and dimensions, and since alternating stresses are less amenable to prediction, stress calculations for parts before construction often are impossible or inaccurate. This has seriously hampered the designing of parts for satisfactory service life.

However, recent advances in experimental stress measurement tech-

*G. H. Found, "The Notch Sensitivity in Fatigue Loading of Some Magnesium Base and Aluminum Base Alloys." Submitted for publication in ASTM.

**The first in a series of papers sponsored by a new subcommittee of the Aluminum and Magnesium Division of A.F.A. This committee is entitled "Design and Stress Measurement in Magnesium and Aluminum Castings" with Charles E. Nelson, Dow Chemical Co., Midland, Mich., as chairman. It is expected that later papers will deal specifically with such direct subjects as the effects of certain mechanical finishes on castings and how they may be obtained; on methods of predicting and measuring stresses on experimental and production castings and how to design for most efficient use of metal in such parts. The general aim is to present actual worthwhile information on what factors are really important to serviceability of castings in such a manner that engineers and foundrymen can meet on a common ground of understanding.**

Presented at an Aluminum and Magnesium Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 7, 1946.

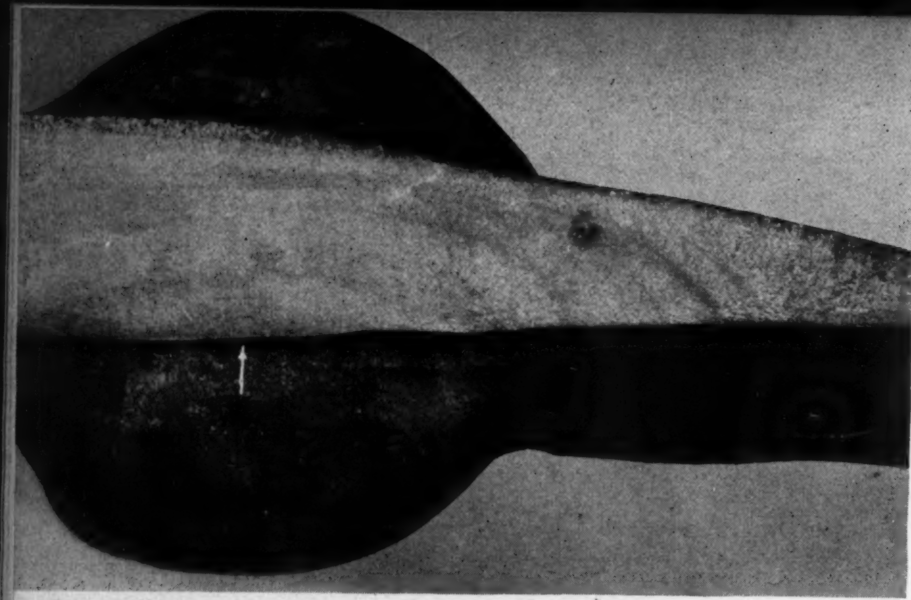


*Fig. 1—Interface of a fatigue failure at a critical location in a magnesium air-conditioning fan of obsolete design. Note typical point origin of failure at surface (at arrow) and evidence of progressive encroachment of fissure into metal. Bending stresses predominated.*

*Fig. 2—Interface of a fatigue failure in a critical region of a magnesium landing wheel. Note same characteristics of failure as in Fig. 1. Bending stress predominated.*

niques with SR-4 electric strain gauges and brittle lacquers have provided the designer with a tool that will enable him to achieve uniquely efficient casting design and, at the same time, satisfactory service life.

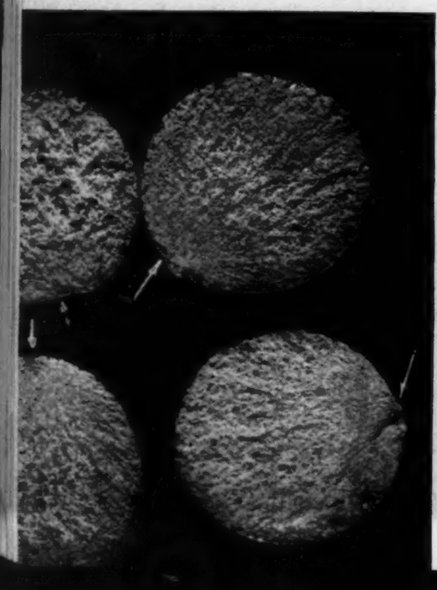
Studies of service failures and service parts have demonstrated that a better appreciation for the factors that are of fundamental importance in fatigue phenomena is necessary. A clearer understanding of the relative importance of internal metallurgy, mechanical surface condition and design on the resistance to fatigue failures must be obtained.

It is evident from this conclusion that an effort must be made to better acquaint design engineers, foundrymen, quality control men and other metallurgists alike with the factors affecting fatigue properties and serviceability which have been learned from service and service-simulating experiences.

It is the purpose of this paper to assist in remedying this last factor by arriving at some working ideas about fatigue behavior from fatigue experiences gained to date. Several interesting relations found to exist between service failures and defects

*Fig. 3 (below, left)—Interface of fatigue failures induced in laboratory test bars in axial loading fatigue tests. Note that points of origin of failures are at surface. Uniform stresses across cross section existed. 2X.*

*Fig. 4 (below)—Interfaces of fatigue failures induced in aircraft motor castings show inception of failure at surface at foundry defects extending to the surface. Fatigue portion of failure is localized around these defects (at arrows). Uniform stresses across cross section existed.*



in metallurgy and design are brought to attention in this discussion.

*Evidence for the Nature of Fatigue Failures: Importance of Points of Weakness and Surfaces.* The static strength of cross sections upon which loads are imposed may be evaluated in terms of the aggregate strength of the entire cross section. Thus, if any point of weakness is observed within a cross section, the static strength of the cross section is automatically thought of in terms of the net load-carrying ability of the remaining non-defective cross section.

## Fatigue Resistance

Unfortunately, this and other simple conceptions of static strength do not apply as the basis for thought about fatigue problems. In other words, the strength to resist failure of a metal area under alternating stress application should not be rationalized on the basis of static strength criteria.

There has been a tendency to focus attention upon factors of relatively minor importance such as grain size, internal porosity, and other metallurgical factors rather than to consider some of the factors such as designed-in stress concentrations, surface quality, and the absolute location of porosity and defects which have a much more important bearing upon the fatigue properties or serviceability of the casting.

Shown in Figs. 1 and 2 are sections through fatigue failures in two large magnesium castings in locations where bending stresses pre-

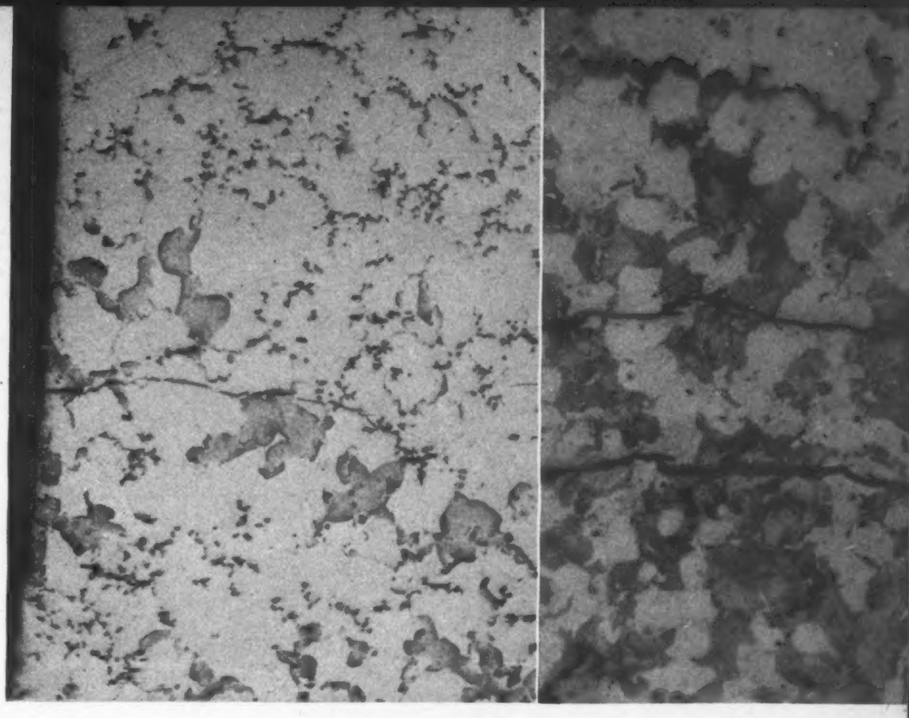


*Fig. 7 (left)—Microsection of a fatigue failure induced in a part showing the relative independence between the course of the failure and the location of concentrated porosity. 50X. (Right)—Fatigue failures through a part showing independence between course of failure and proximity of nearby porosity. 75X.*

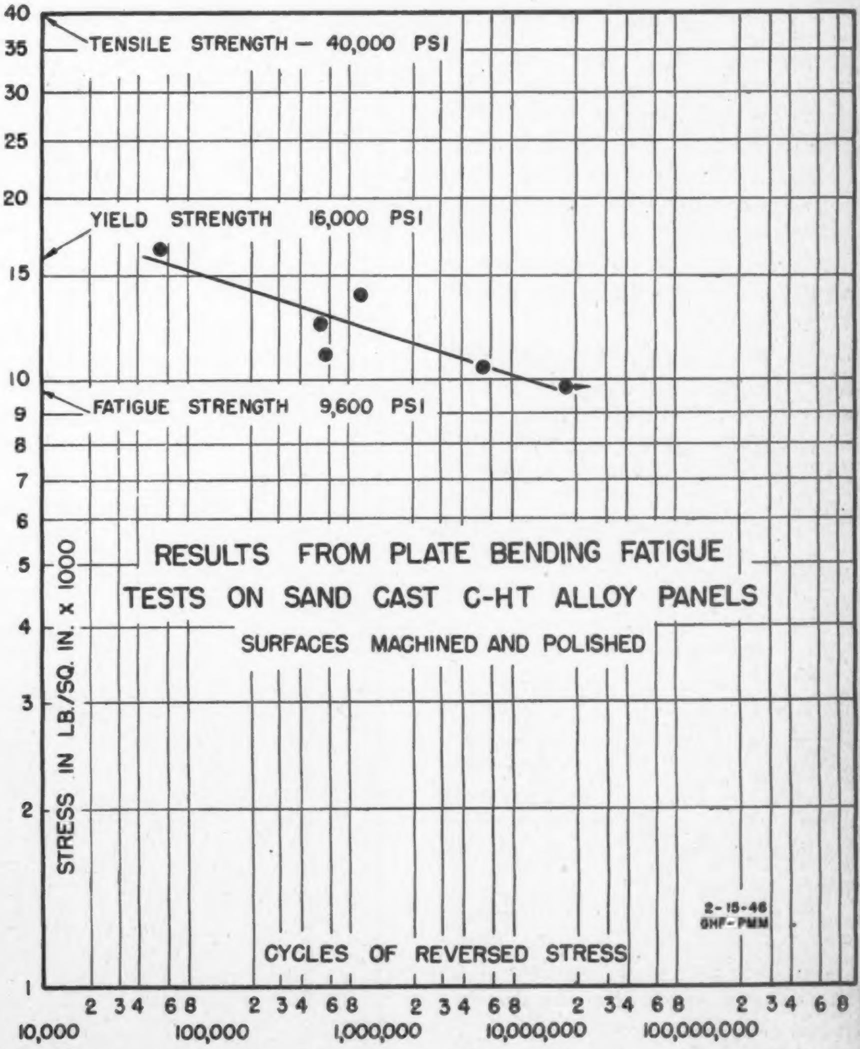
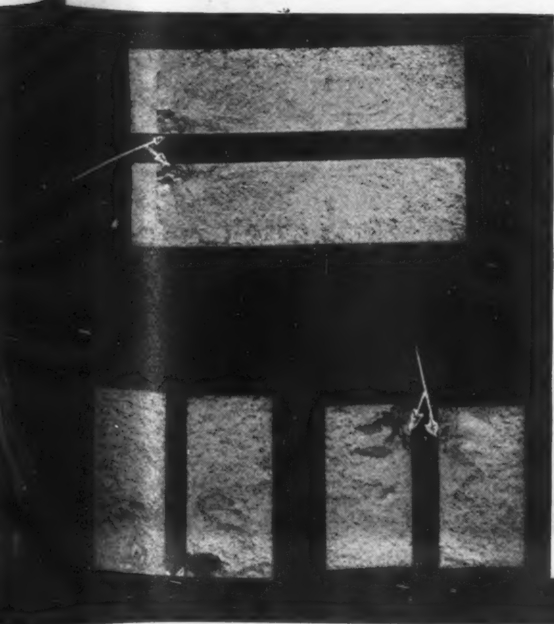



*Fig. 6—Typical fatigue curve showing fatigue properties of cast panels and the static properties of the same material.*

*Fig. 5—Fatigue failures in cast magnesium test panels showing failures originating at defects (at arrows) which extend to the surface. 2X.*



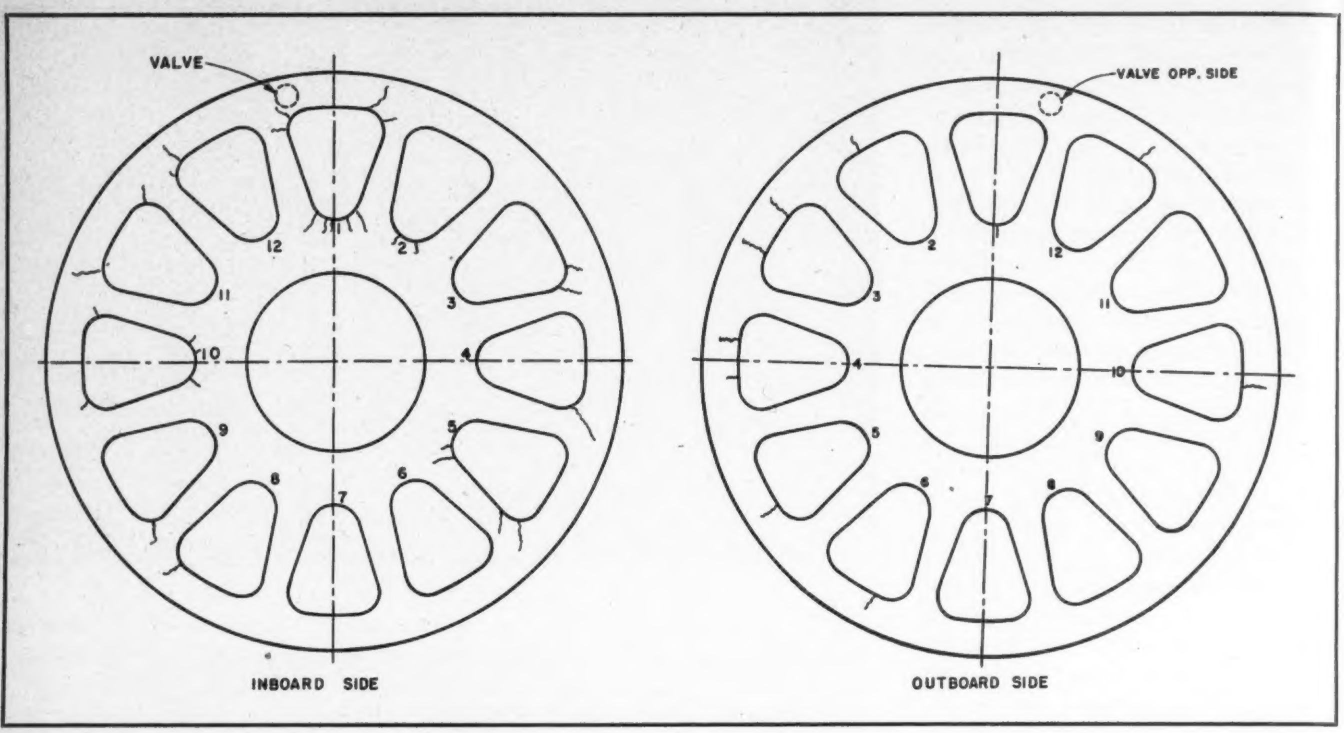



*Fig. 8—Diagrammatic views of inboard and outboard sides of an aircraft wheel showing location of roll test failures.*

dominated. Failure occurred at points of maximum tensile strength.

In Figs. 3 and 4 are fatigue failures induced in the laboratory in test bars and in a casting, respectively, by axial stresses, that is, stresses which are uniform across the cross section.

The general appearance of these failures shown in Figs. 1 to 4 is typical of all fatigue failures in cast magnesium. Fatigue failures (except in special cases where they are influenced by artificially induced, high surface stresses) always originate at the surface of the metal, whether stressing is due to bending or axial loading.

### Failure Characteristics

Failures progress inward leaving interfaces marked with rings or bands concentrically arrayed about the point of inception of the failure. In Figs. 4 and 5 it will be noted that failure by fatigue originated at visible local defects which extended to the surface layer.

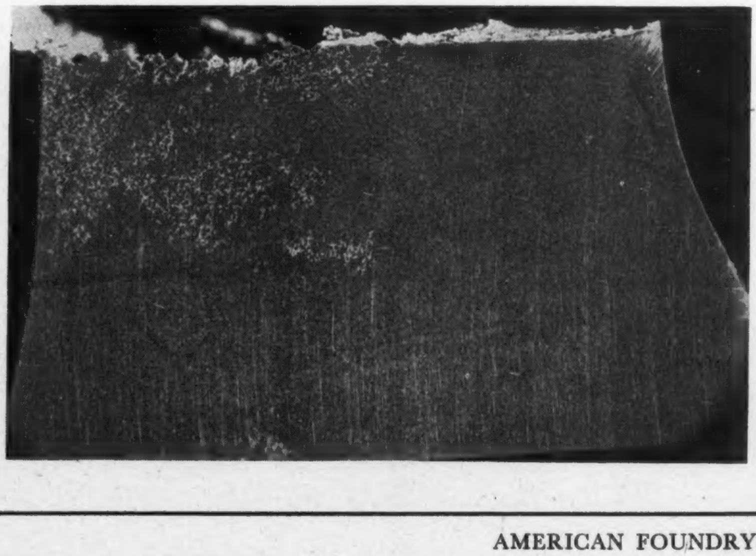
It is evident from these illustrations that fatigue failures always start at points in the surface of the metal and propagate inward with each successive cycle of stress. Fatigue strength of the metal is thus not as much a function of the aggregate net strength of the non-defective section as it is a function of the strength of any defective area. This can be thought of as a reason why the fatigue strength of materials is considerably below their static strength, as shown for a given cast magnesium alloy in Fig. 6.

*Relative Importance of the Subsurface Metallurgy.* Since the importance of the condition of the surface layers has now been emphasized, it is interesting to investigate what influence the condition of the metal below the surface may have on the serviceability of the metal.

Examinations of many service parts have shown repeatedly that failures may occur in uniformly stressed regions through sound areas even as close as a small fraction of an inch removed from areas containing subsurface microporosity in various amounts.

Figure 7 is a microsection through such a failure showing a fatigue crack which originated at a point only slightly removed from a region

*Fig. 9—Sectioned out region of wheel in Fig. 8 showing fatigue failure interface and subsurface porosity. 6X.*



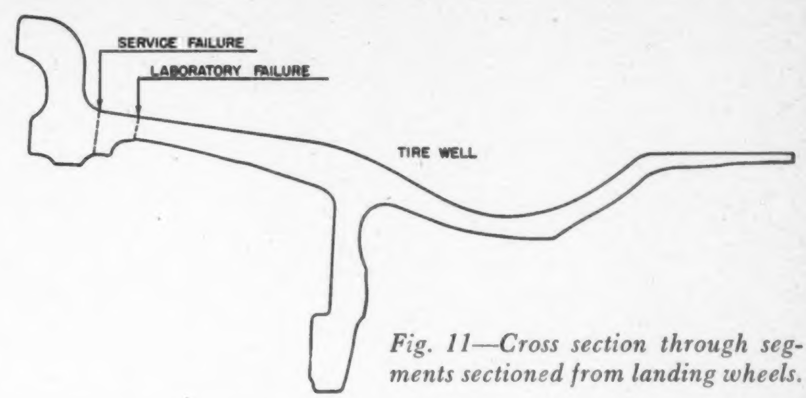



*Fig. 11—Cross section through segments sectioned from landing wheels.*

of concentrated microspority located just below the surface.

Laboratory fatigue tests of the cantilever bending type of cast magnesium panels containing microporosity show similar results. With a few random exceptions, if failure does occur through microporosity or a defective region, such regions extend to the surface layer of the panels, as already shown in Fig. 5.

In Fig. 4 the same effect has been shown in fatigue tests on aircraft motor castings. The failures started at foundry defects at the surface of these particular parts in Fig. 4. Failures in other similar parts of this design during laboratory tests often occurred through sound metal adjacent to subsurface porous regions.

### General Indications

The observations just discussed are not intended to obscure the fact that failures have occasionally been observed through subsurface porosity in uniformly stressed regions in test panels and parts.

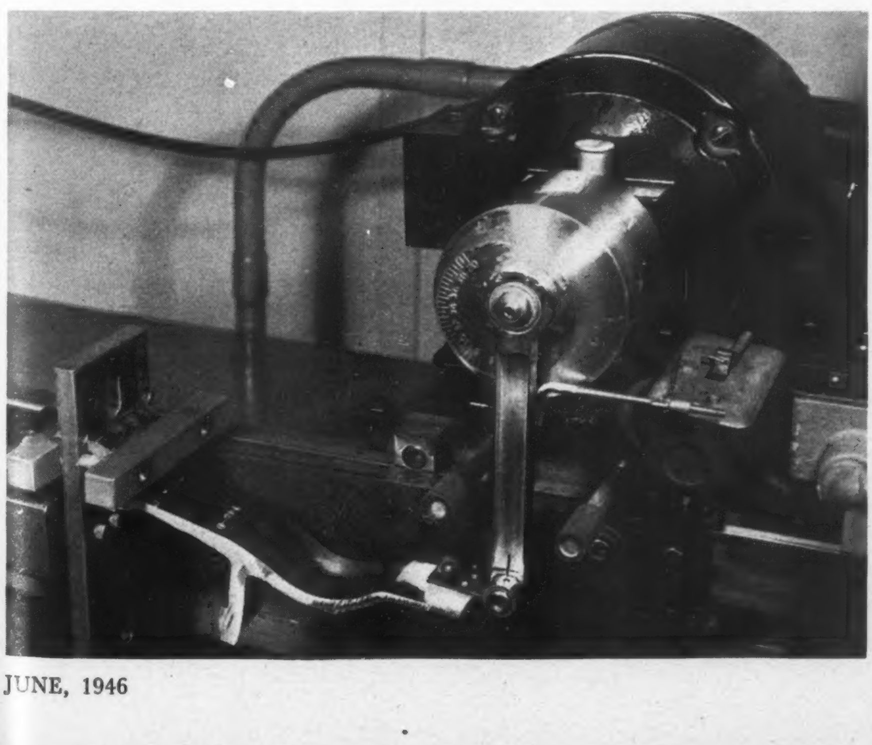
However, the frequency of these occurrences is not only random with respect to any measurable variable in the porosity within the tolerable limits of porosity, but also is small when compared to the number of instances when failures have occurred at either defective surface regions or regions metallurgically perfect adjacent to internal defects.

If there were no instances of even random failure through subsurface porosity, this would indicate that subsurface porosity strengthens the cross section, which, of course, is not so.

*Relative Importance of Design and Metallurgy.* So far, the discussion has been concerned only with regions of cast metal which have been uniformly stressed. Failures which occur in uniform sections of service parts where design complications are not involved would approximate these conditions.

However, critical regions in service castings usually are at locations of complex design where non-uniform stressing, or stress concentrations, exist. Accordingly, it is well to consider applications which involve non-uniform stressing with regard to the influence of surface effects, internal porosity and design.

*Fig. 10—Testing arrangement for fatigue tests on wheel segments.*



An ideal example for the discussion of this subject is a certain cast magnesium aircraft landing wheel which, in its early design stage, was roll tested to failure. Failures occurred in the wheel short of the desired life. The locations of the failures are shown in the diagrammatic views of this wheel in Fig. 8.

### Observations

It will be noted that a relationship exists between the location of the failures and the design features on each side of the wheel. Failures were confined to the fillet regions around the spokes on the inboard side of the wheel, while they tended to be between the fillets on the peripheral side of the spoke windows on the outboard side of the wheel.

Radiographic examinations revealed that microporosity existed in the wheel in several areas in amounts which approach unacceptability. This was an early model of the wheel. The foundry, therefore, had not cast a sufficient number to completely solve its porosity problem. In a few instances the roll test failures protruded into regions of this porosity, as shown in the photomicrograph in Fig. 9.

In this figure the failure interface is the upper edge of the metal. The fatigue portion (straight portion) of the failure originated in sound metal at the surface on the right side and extended into the area of porosity at the left. The jagged portion of the failure is the interface formed when the specimen was statically broken after it had been subdivided from the wheel.

In appraising the presented information about this failure, the principal conclusion reached, on the

basis of false conceptions about the factors affecting fatigue strength and serviceability, would have been that the porosity caused the failure. On this basis, efforts to make the wheel sound may have been deemed sufficient to give a serviceable wheel.

Actually, however, the porosity was of minor importance and perhaps even inconsequential. This can be reasoned, first, from the fact that the location of the porosity is random with respect to the location of the failures. (As already observed, the failures were oriented with quite definite relation to the design of the wheel.)

In the second place, previous experiences have indicated that internal porosity has an effect secondary in comparison to the influence of metallurgical conditions existing at the metal surface.

Failure in this wheel, then, was caused only by inadequacies in the design of the wheel, since failures occurred in sound as well as in porous metal. New wheels were produced after certain design changes had been made.

### Additional Determinations

In the preceding experience with the landing wheel failure, it was stated on the basis of the tests on cast panels that the porosity in the wheel may not have been of even secondary importance. The results from a fatigue testing program which was carried out on a number of segments sectioned from a landing wheel of given design further substantiate this conclusion.

These segments were flexed to failure on plate bending fatigue machines, as shown in Fig. 10. At the point of failure in this test, which was in the proximity of the location of service fatigue failures (See Fig. 11) porosity existed in amounts corresponding to a variation in the estimated tensile strength of from 25,000 to 33,000 psi. from specimen to specimen.

The results of these tests are plotted in Fig. 12. It will be noted that the test points exhibit little scatter despite the variation in porosity. The scatter in results that does exist bears no relation to the amount of porosity present. In fact, the actual fatigue strength values for these specimens are of the same order as found in cast panels of the same alloy of the highest metallurgical and surface quality commercially obtainable.

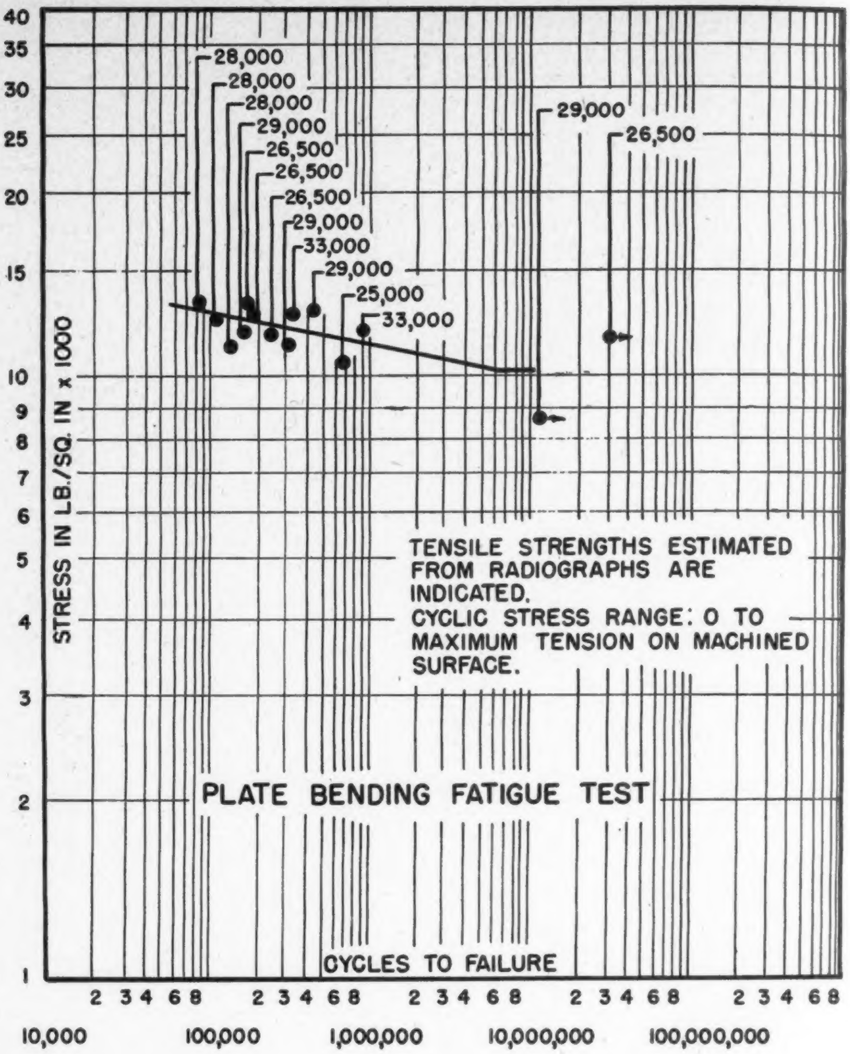



*Fig. 12—Results of fatigue tests on wheel segments.*

The conclusion to be made from the foregoing tests is that subsurface microporosity in amounts within the acceptable limits does not impair the bending fatigue properties of magnesium.

### Porosity Standards

Several interesting relations between service failure and defects in metallurgy and design have been shown. However, it is not intended that confusion be left regarding how porosity should be considered in a casting on the basis of these recounted experiences. The relaxation of standards regarding porosity is not implied.

Such an action would be without due cognizance of either the influence of internal porosity on static properties or the effect of surface porosity on fatigue properties. In addition, the presence of internal porosity in various sections often is associated with defects at the surface.

In summary, it has been the intention to present information which will stimulate more genuine interest in porosity and its actual effect upon serviceability, and to point out that design and conditions at the surface of the metal are of primary importance on fatigue serviceability while internal metallurgy and static strength criteria are of secondary importance.

### Conclusions

Fatigue failures originate at points of relative weakness in metal surfaces.

Service and laboratory experiences on parts uniformly stressed show that fatigue failures will be perfectly random in location with respect to internal microporosity or metallurgy; that is, the location of failure has no apparent relationship

to the proximity of internal defects. The effect of internal metallurgy appears, therefore, to have little influence on serviceability compared to the effect of either the surface or design features. Failures frequently occur through foundry defects or porosity that extend to the surface of metal in the part.

In parts of complex design where stresses are not uniform and stress concentrations exist, the influence on the serviceability of the stress concentration associated with the design surpasses any influence that subsurface porosity may have.

# A.F.A. ORGANIZED
## *At 1896 Philadelphia Convention*

MOST PRONOUNCED ASPECT of the first A.F.A. Convention in Philadelphia, 1896, was the enthusiasm among foundrymen who gathered from all corners of the American continent for the three day meeting, June 12-14, that was to result in formation of the Association.

Foresight of the nearly 350 delegates who answered the call of Philadelphia's Foundrymen's Association for a national meeting was evident. There was recognition of the importance of the castings industry in the overall economic picture, and of the benefits, to that industry, of a continent-wide organization to bring all foundrymen together, to stimulate advancement of foundry technology, to promote exchange of information regarding new developments and meet a host of other needs in the expanding field.

### Organization Hailed

Eagerness for the task of fashioning such an organization ran high among foundry representatives and was reflected by others who took part in meetings. Mayor Warwick, of Philadelphia, delivered his welcoming address in a vein of high humor, describing 'casting' of the nation's constitution in the historic city by the 'founders' of the government, and using foundry terminology similarly in other remarks.

Considerable satisfaction at advent of the Association was expressed in the name of National Association of Manufacturers, by its president, T. C. Search, who delivered an addressed following that of Mayor Warwick. The great industrial potential of America, already evident at that time, was clearly portrayed by Mr. Search, who characterized the purpose of the convention: creation of a "national assemblage" and encouragement of organization of local groups, as "indicative of the needs of the day."

Objects of the gathering were sharply defined by the final address prior to the initial business session, by H. W. Pafhler, Abraham Cox Stove Co., Philadelphia, a prominent foundryman and noted speaker on foundry topics. Mr. Pafhler related the great successes attending formation of foundry groups on local scale, and thus added another auspicious note to the proceedings.

Prompt adoption, without discussion, of a resolution to form an American foundrymen's association and to appoint a constitutional committee, launched the business of the convention. Francis Schumann, Tacony Iron & Metal Co., Philadelphia, who had been elected temporary chairman by unanimous vote, immediately appointed a constitutional committee and a committee on nominations; and the committees plunged into their work, while delegates gave their attention to outstanding technical papers.

Animated discussion, representative of the broadest cross-section of the industry that had ever been brought together for consideration of foundry problems, attended presentation of the papers. For the first time, theories, prejudices and practical experience from every corner of the American continent were brought to bear on aspects of technology, and representatives benefited from free exchange of ideas Similar benefits sprang from acquaintanceships developed among foundrymen in the many social events that took place during the three days.

### Accept Committee Reports

Meanwhile, the committees worked swiftly, and the constitution was presented to the delegates on the afternoon of the second day—winning hearty approval in general, so that it was adopted with minor changes the following morning.

Similar popular acclaim greeted the report of the committee on nominations, whose recommendations were adopted without change: *President,* Francis Schumann; *Secretary,* J. A. Penton, editor, *The Foundry,* Detroit; and *Treasurer,* Howard Evans, J. W. Paxson & Co., Philadelphia.

With its task concluded, the convention adjourned; and delegates left in a jubilant, triumphant mood to report on their success. They had created the American Foundrymen's Association, not a "national" organization confined to the boundries of the United States, but one intended to draw together the foundrymen of the entire American continent.

*Group of American foundrymen in attendance at the first A.F.A. convention held in Philadelphia 50 years ago.*

# THE CUPOLA HANDBOOK

By R. G. McElwee

Chairman, Cupola Research Committee

FOLLOWING THESE REMARKS will be found an announcement of THE CUPOLA HANDBOOK which is the first tangible evidence of the vast amount of research and editorial work performed by the Cupola Research Committee. It is essentially a progress report and prepared in accordance with instructions given the Cupola Research Committee to survey and record the known data relative to the cupola, in order to indicate clearly the path to be followed by later research.

The Cupola Research Committee was organized from the outstanding technicians and investigators, both academic and practical, and assignments of various phases were given to men who were recognized as authorities in the field in which their particular Cupola Research Sub-Committees worked. They were asked to keep constantly before them the pattern of a handbook which would be at once theoretically sound and thoroughly practical.

It is felt that they have adhered closely to the pattern and that the book will be useful to the operator who does not wish to become involved in the theory of combustion, but who wishes some clearly stated rules by which his cupola can be operated. It will be equally prized by the manager of a large melting department who wants the constants, formulas, etc., at his elbow and readily available.

Those assignments dealing with equipment have been treated in such manner that the reader can feel he has had contact with a user of the particular equipment and that the data given has been re-written and criticized to free it from any taint of advertising. In this phase the Cupola Research Committee was extremely critical, and a splendid spirit was displayed by equipment manufacturers in supplying unimpeachable operating facts.

Toward the contributors, who displayed remarkable patience, the Cupola Research Committee feels grateful. For a long time there was little that could be reported except "we are making progress." Their faith in the final outcome has been a source of great satisfaction to all who served.

The point has now been reached where two things must be done. The real research work for which the funds were contributed must be organized and pushed vigorously. With the sale of the book the fund should approach its original total, money which will be used for those phases of cupola operation which the Cupola Research Committee found devoid of reliable data.

The second thing is to get the book into the hands of every cupola operator so that he will use it daily, criticize it if necessary, but apply all of the information given so unstintingly by the many to whom "the book" became their main concern.

It is the hope of all of us that we will see THE CUPOLA HANDBOOK in the shop as well as the office, and it will be serving its purpose best if many copies find their way to the cupola operator's home for more careful study.

AT THE 1946 A.F.A. convention the first copies of the HANDBOOK OF CUPOLA OPERATION were placed on sale at the A.F.A. publication booth. This handbook, the culmination of many years work, is the result of over 200 individuals who made up the Cupola Research Committee and who gave unstintingly of their time and effort. The American Foundrymen's Association wishes to acknowledge the unselfish cooperation of both these individuals and their companies, for without such cooperation this project would not have been possible.

To finance the work of the Cupola Research Committee, the Finance Committee secured the pledges of 276 companies to finance the project over a five-year period. A total of $50,000.00 was raised and of this amount $47,000.00 has been collected to date.

In finished form, the first edition of the HANDBOOK OF CUPOLA OPERATION takes its place among the vast amount of information and data published by the American Foundrymen's Association. As the first publication of its kind, it will undoubtedly be one of the most valuable volumes ever issued by the Association.

The HANDBOOK OF CUPOLA OPERATION contains 468 pages and is profusely illustrated with pictures and graphs. It will be a "must" for any library of foundry practice and technology.

A list of the committee personnel follows:

**Executive Committee**

*Chairman* (1939-41) A. L. Boegehold, Met. Dept., General Motors Research Labs. Div., General Motors Corp., Detroit, Mich.

*Chairman* (1941-43) D. J. Reese, International Nickel Co., New York, N. Y.

*Chairman* (1943-to date) R. G. McElwee, Vanadium Corp. of America, Detroit, Mich.

H. C. Aufderhaar, Electro Metallurgical Co., Chicago, Ill.

H. Bornstein, Deere & Co., Moline, Ill.

J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.

H. Kenneth Briggs, Miller & Co., Chicago, Ill.

C. O. Burgess, Electro Metallurgical Co., Niagara Falls, N. Y.

A. E. Caudle, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

V. A. Crosby, Climax Molybdenum Co., Detroit, Mich.
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.
G. S. Evans, Mathieson Alkali Works, New York, N. Y.
A. W. Gregg, Whiting Corp., Harvey, Ill.
L. C. Hewitt, Laclede-Christy Clay Products Co., St. Louis, Mo.
T. G. Johnston, Republic Steel Corp., Republic Bldg., Cleveland, Ohio
J. A. Kayser, Laclede-Christy Clay Products Co., St. Louis, Mo.
Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.
John Lowe, Hansell-Elcock Co., Chicago, Ill., (Formerly Vitler Mfg. Co., Milwaukee)
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
S. C. Massari, Major, U. S. Army Ordnance, Chicago, Ill. (Formerly Association of Mfgrs. of Chilled Car Wheels, Chicago)
Lewis D. McClaren, Republic Coal & Coke Co., Chicago, Ill.
R. G. McElwee, Vanadium Corp. of America, Detroit, Mich.
W. O. McMahon, Foundry Consultant, Birmingham, Ala. (Formerly Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.)
R. S. Moore, Harbison-Walker Refractories Co., Pittsburgh, Pa.
B. P. Mulcahy, Citizens' Gas & Coke Utility, Indianapolis, Ind.
B. C. O'Brien, Roots-Connersville Blower Co., Connersville, Ind.
G. P. Phillips, International Harvester Co., Chicago, Ill.
C. S. Reed, Jr., Chicago Retort & Fire Brick Co., Chicago, Ill.
D. B. Reeder, Electro Metallurgical Co., San Francisco, Calif.
A. E. Schuh, U. S. Pipe & Foundry Co., Burlington, N. J.
L. N. Shannon, Stockham Pipe Fittings Co., Birmingham, Ala.
H. S. Simpson, National Engineering Co., Chicago, Ill.
E. K. Smith, Consultant, Beverly Hills, Calif. (Formerly Electro Metallurgical Co., Chicago, Ill.)
Jas. Thomson, Continental Foundry & Machine Co., East Chicago, Ind.
F. J. Walls, International Nickel Co., Detroit, Mich.
H. S. Washburn, Plainville Casting Co., Plainville, Conn.

### Steering Committee

*Chairman* (1941-43) D. J. Reese, International Nickel Co., New York, N. Y.
*Chairman* (1943-to date) R. G. McElwee, Vanadium Corp. of America, Detroit, Mich.
Max Kuniansky (1941-to date) Lynchburg Foundry Co., Lynchburg, Va.
John Lowe (1941-to date) Hansell-Elcock Co., Chicago, Ill. (Formerly Vilter Mfg. Co., Milwaukee; Battelle Memorial Institute, Columbus, Ohio, and U. S. Pipe & Foundry Co., Burlington, N. J.)
S. C. Massari (1941-to date) Major, U. S. Army Ordnance, Chicago, Ill. (Formerly Association of Manufacturers of Chilled Car Wheels, Chicago, Ill.)
R. G. McElwee, (1941-43) Vanadium Corp. of America, Detroit, Mich.
V. A. Crosby (1943-to date) Climax Molybdenum Co., Detroit, Mich.
A. E. Schuh (1943-to date) U. S. Pipe & Foundry Co., Burlington, N. J.
G. S. Evans (1944-to date) Mathieson Alkali Works, New York, N. Y.
G. P. Phillips (1944-to date) International Harvester Co., Chicago, Ill.

### Cupola Operations Handbook Editor

E. E. Marbaker, Mellon Institute, Pittsburgh, Pa. (1941)

### Subcommittee on Equipment

*Chairman* (1940-42) A. W. Gregg, Whiting Corp., Harvey, Ill.
*Chairman* (1942-to date) Jas. Thomson, Continental Fdry. & Machine Co., East Chicago, Ind.
*Vice Chairman* (1942-to date) W. R. Jennings, John Deere Tractor Co., Waterloo, Iowa
*Secretary* (1942-to date) A. DeYoung, Whiting Corp., Harvey, Ill.
J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.
M. J. Bradley, Leeds & Northrup Co., Philadelphia, Pa.
A. E. Caudle, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
D. A. Damm, Surface Combustion Co., Toledo, Ohio
G. S. Evans, Mathieson Alkali Works, New York, N. Y.
W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
W. C. Juram, Jr., Bristol Co., Waterbury, Conn.
John Lowe, Hansell Elcock Co., Chicago
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
B. A. Miller, Cramp Brass & Iron Foundries Div., Baldwin Locomotive Works, Philadelphia, Pa.
B. C. O'Brien, Roots-Connersville Blower Co., Connersville, Ind.
Wm. Pugsley, The Hays Corp., Michigan City, Ind.
W. Lee Roueche, McWane Cast Iron Pipe Co., Birmingham, Ala.
M. A. Schreiner, Foxboro Co., Foxboro, Mass.
A. E. Schuh, U. S. Pipe & Foundry Co., Burlington, N. J.
L. C. Smith, Spencer Turbine Co., Hartford, Conn.
P. T. Sprague, Hays Corp., Michigan City, Ind.
J. C. Thomas, Whiting Corp., Harvey, Ill.
F. K. Vial, Griffin Wheel Co., Chicago
R. E. Wilke, Deere & Co., Moline, Ill.

### Subcommittee on Ferrous Materials and Alloys

*Chairman,* R. G. McElwee, Vanadium Corp. of America, Detroit, Mich.

### Subcommittee on Pig Iron

*Chairman,* T. G. Johnston, Republic Steel Corp., Cleveland, Ohio
B. H. Booth, Carpenter Bros., Milwaukee, Wis. (Formerly Jackson Iron & Steel Co., Jackson, Ohio)
Fred Carl, Delco-Remy Div., General Motors Corp., Anderson, Ind.
A. H. Dierker, Globe Iron Co., Jackson, Ohio
R. A. Donaldson, Woodward Iron Co., Woodward, Ala.
H. W. Johnson, Inland Steel Co., East Chicago, Ind.
T. L. Joseph, University of Minnesota, Minneapolis, Minn.
M. J. Lefler, Strom Brass Foundry, Elkhart, Ind. (Formerly Western Foundry Co., Chicago, Ill.)
R. A. Lindgren, Wisconsin Steel Works, South Chicago, Ill.
E. C. Mathis, Pickands Mather & Co., Chicago
W. O. McMahon, Foundry Consultant, Birmingham, Ala. (Formerly Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.)
J. E. Reynolds, U. S. Pipe & Foundry Co., Bessemer, Ala.
W. G. Reichert, W. G. Reichert Engineering Co., Newark, N. J. (Formerly American Brake Shoe & Fdry. Co., Mahwah, N. J.)
H. M. Rich, Hickman Williams & Co., Detroit, Mich.

### Subcommittee on Scrap

*Chairman,* Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.
H. C. Aufderhaar, Electro Metallurgical Corp., Chicago, Ill.
H. Bornstein, Deere & Co., Moline, Ill.
D. H. Meloche, Institute of Thermal Research, Yonkers, N. Y.
L. W. Pryse, Hickman Williams & Co., Cincinnati, Ohio. (Rep. Institute of Scrap Iron and Steel)
W. G. Reichert, W. G. Reichert Engineering Co., Newark, N. J. (Formerly American Brake Shoe Co., Mahwah, N. J.)
E. K. Smith, Consultant, Beverly Hills, Calif. (Formerly Electro Metallurgical Co., Detroit)
H. W. Stuart, U. S. Pipe & Foundry Co., Burlington, N. J.

### Subcommittee on Alloys

*Chairman,* R. G. McElwee, Vanadium Corp. of America, Detroit, Mich.
H. C. Aufderhaar, Electro Metallurgical Corp., Chicago, Ill.
T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio. (Formerly Vanadium Corp. of America, Detroit, Mich.)
G. F. Comstock, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
V. A. Crosby, Climax Molybdenum Co., Detroit, Mich.
V. H. Schnee, Battelle Memorial Institute, Columbus, Ohio
E. K. Smith, Consultant, Beverly Hills, Calif. (Formerly Electro Metallurgical Co., Detroit, Mich.
F. J. Walls, International Nickel Co., Detroit, Mich.
R. J. Zemanek, U. S. Graphite Co., Saginaw, Mich.

### Subcommittee on Slags, Fluxes and Desulphurizers

*Chairman,* G. S. Evans, Mathieson Alkali Works, New York, N. Y.
W. Van N. Baker, Standard Foundry Co., Worcester, Mass.
J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.
Wayne Cockrell, Michigan State College, East Lansing, Mich.

*(Continued on page 52)*

## THE CUPOLA HANDBOOK

*(Continued from page 51)*

A. W. Demmler, Campbell, Wyant & Cannon Co., Muskegon, Mich. (Formerly Vanadium Corp. of America, Bridgeville, Pa.)
A. H. Dierker, Ohio State University, Columbus, Ohio
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.
H. H. Judson, Goulds Pumps, Inc., Seneca Falls, N. Y.
M. J. Lefler, Strom Brass Foundry, Elkhart, Ind. (Formerly Western Foundry Co., Chicago)
C. H. Lorig, Battelle Memorial Institute, Columbus, Ohio
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
L. H. Rudesill, Griffin Wheel Co., Chicago, Ill.
R. Schneidewind, University of Michigan, Ann Arbor, Mich.
F. W. Scott, Marquette Mfg. Co., Minneapolis, Minn. (Formerly University of Minnesota, Minneapolis, Minn.)
H. Womochel, Michigan State College, East Lansing, Mich.

#### Subcommittee on Fuels and Combustion

*Chairman,* S. C. Massari, Major, U. S. Army Ordnance, Chicago. (Formerly Association of Manufacturers of Chilled Car Wheels, Chicago)
J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.
H. L. Comin, Indiana Gas & Chemical Corp., Terre Haute, Ind.
Gordon Creusere, Semet-Solvay Co., Detroit, Mich.
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.
G. S. Evans, Mathieson Alkali Works, New York, N. Y.
A. Hawes, Wheeling Steel Corp., Cincinnati, Ohio
F. W. Jung, Koppers Co., Kearney, N. J.
Stanley F. Levy, Black-Clawson Co., Hamilton, Ohio
R. W. Lindsay, Pennsylvania State College, State College, Pa. (Formerly Association of Manufacturers of Chilled Car Wheels, Chicago)
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
Lewis D. McClaren, Republic Coal & Coke Co., Chicago, Ill.
M. F. Milligan, Lunkenheimer Co., Cincinnati, Ohio
B. P. Mulcahy, Citizens' Gas & Coke Utility, Indianapolis, Ind.
R. A. Sherman, Battelle Memorial Institute, Columbus, Ohio
F. K. Vial, Griffin Wheel Co., Chicago, Ill.
T. J. Wood, American Brake Shoe Co., Mahwah, N. J.

#### Subcommittee on Operation and Process

*Chairman* (1940-42) G. P. Phillips, International Harvester Co., Chicago, Ill.
*Chairman* (1942-to date) H. Kenneth Briggs, Miller & Co., Chicago, Ill.
*Vice-Chairman* (1940-42) H. Kenneth Briggs, Miller & Co., Chicago, Ill.
*Vice-Chairman* (1942-to date) G. P. Phillips, International Harvester Co., Chicago
J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.
E. Bremer, *The Foundry,* Cleveland, Ohio.
J. L. Brooks, Sparta Foundry Div., Muskegon Piston Ring Co., Sparta, Mich.
W. H. Brooks, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
G. E. Clark, Cummins Engine Co., Columbus, Ind.
L. A. Colangelo, International Harvester Co., Chicago, Ill.
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.
H. J. Dunleavy, Benton Harbor Malleable Industries, Benton Harbor, Mich.
E. W. Engstrom, International Harvester Co., Rock Island, Ill.
F. E. Fisher, Hydro-Blast Corp., Chicago, Ill.
R. Flora, Clover Foundry Co., Muskegon, Mich.
John H. Gellert, Nichol-Straight Foundry Co., Chicago, Ill.
John Grennan, University of Michigan, Ann Arbor, Mich.
W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Fulton Holtby, University of Minnesota, Minneapolis, Minn.
G. W. Johnson, American Hoist & Derrick Co., St. Paul, Minn.
C. F. Joseph, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.
J. J. Kanter, Crane Co., Chicago, Ill.
A. S. Klopf, L. B. Knight & Associates, Chicago, Ill.
M. J. Lefler, Strom Brass Foundry, Elkhart, Ind. (Formerly Western Fdry. Co., Chicago)
J. T. Leisk, Chicago Hardware Foundry Co., North Chicago, Ill.
J. P. Lentz, International Harvester Co., Indianapolis, Ind.
W. Levi, Lynchburg Foundry Co., Lynchburg, Va.
W. S. Linnell, Wisconsin Steel Co., Chicago, Ill.
Leighton M. Long, Leighton M. Long & Associates, Toledo, Ohio. (Formerly Bunting Brass & Bronze Co., Toledo, Ohio)
John Lowe, Hansell-Elcock Co., Chicago. (Formerly Vilter Mfg. Co., Milwaukee)
H. W. Maack, Crane Co., Chicago, Ill.
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
E. C. Mathis, Pickands Mather & Co., Chicago, Ill.
Earl L. Nelson, Crane Co., Chicago, Ill.
W. A. Pennington, Mellon Institute, Pittsburgh, Pa.
Willard H. Rother, Buffalo Foundry & Machine Co., Buffalo, N. Y.
L. H. Rudesill, Griffin Wheel Co., Chicago, Ill.
A. E. Schuh, U. S. Pipe & Foundry Co., Burlington, N. J.
L. M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I.
H. K. Sohner, International Harvester Co., Milwaukee, Wis.
L. B. Thomas, Wilson Foundry & Machine Co., Pontiac, Mich.
F. J. Walls, International Nickel Co., Detroit, Mich.
R. E. Wilke, Deere & Co., Moline, Ill.

#### Subcommittee on Refractories

*Chairman* (1941-42) C. S. Reed, Jr., Chicago Retort & Fire Brick Co., Chicago, Ill.
*Chairman* (1942-44) J. F. Oesterle, University of Wisconsin, Madison, Wis. (Deceased)
*Chairman* (1944-to date) C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio
J. A. Bowers, American Cast Iron Pipe Co., Birmingham, Ala.
C. A. Brashares, Harbison Walker Refractories Co., Pittsburgh, Pa.
E. J. Carmody, Chas. C. Kawin Co., Chicago, Ill.
W. D. Chadwick, Novelty Foundry & Iron Works, Sterling, Ill.
R. A. Clark, Electro Metallurgical Co., Chicago, Ill. (Formerly Lakey Foundry & Machine Co., Muskegon, Mich.)
C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.
J. O. Everhart, Kentucky Fire Brick Co., Haldeman, Ky.
L. C. Hewitt, Laclede-Christy Clay Products Co., St. Louis, Mo.
J. A. Kayser, Laclede-Christy Clay Products Co., St. Louis, Mo.
J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.
P. J. May, Cleveland Quarries Co., Cleveland, Ohio
R. S. Moore, Harbison-Walker Refractories Co., Pittsburgh, Pa.
A. S. Nichols, Illinois Clay Products Co., Chicago, Ill.
E. A. Petersen, Chrysler Corp., Detroit, Mich.
R. P. Stevens, Chicago Retort & Fire Brick Co., Chicago, Ill.
J. D. Sullivan, Battelle Memorial Institute, Columbus, Ohio.

#### Subcommittee on Finance

*Chairman* (1940-42) G. S. Evans, Mathieson Alkali Works, New York, N. Y.
*Chairman* (1942-to date) Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.
(Membership of committee consists of entire personnel of the General Cupola Research Project Committee)

A list of the companies who contributed financially to the Project follows:

Acme Foundry Co., Detroit, Mich.
Acme Foundry Co., Eureka, Calif.
Alabama Clay Products Co., Birmingham, Ala.
John D. Alexander, Cleveland, Ohio
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
The Allyne-Ryan Foundry Co., Cleveland, Ohio
The Almont Mfg. Co., Inc., Imlay City, Mich.
American Brake & Shoe Foundry Co., New York, N. Y.
American Cast Iron Pipe Co., Birmingham, Ala.
American Chain & Cable Co., Inc., Bridgeport, Conn.
American Hardware Corp., New Britain, Conn.
American Hoist & Derrick Co., St. Paul, Minn.
The American Laundry Machinery Co., Rochester, N. Y.
American Seating Co., Grand Rapids, Mich.
America Skein & Foundry Co., Racine, Wis.
Andersen Foundry Co., Bayport, Minn.
Andes Range & Furnace Corp., Geneva, N. Y.
Ann Arbor Foundry Co., Ann Arbor, Mich.

*(Continued on page 64)*

# PREVENTING VEINING AND PENETRATION ON CASTINGS MADE IN SYNTHETIC SANDS

R. E. Morey
and
J. R. Kattus

INCREASED USE of synthetic sands throughout the foundry industry is a convincing indication that their advantages over natural sands in many cases are widely recognized. In order to fill the need of advanced bases, repair ships, and other naval establishments for simplicity in sand practice, a synthetic molding sand and a core sand were developed at the Naval Research Laboratory and recommended for use in making molds and cores for most of the commonly used foundry alloys.

The molding sand mixture consists of washed silica sand with a median size of 180 microns (corresponding approximately to A.F.A. grain size of 80) plus additions of 3.0 per cent bentonite, 1.5 per cent dextrine, 0.5 per cent corn flour, and 3.5 per cent moisture. A core sand employing the same base sand bonded with 1.0 per cent core oil, 1.0 per cent corn flour, and 4 per cent moisture was recommended.

It was realized that the base sand is coarser than normally would be used in making a synthetically bonded sand for use with non-ferrous metals. In order to use one sand for all metals and thus eliminate the necessity of maintaining stocks of two or more kinds of sand on repair ships and at advanced bases, it was felt that a slight sacrifice in surface finish could easily be made. This compromise on grain size permitted the use of the single grade of washed silica sand in the mixture to be used for all metals which normally are required for emergency ship repair.

With few exceptions, sound engineering castings of all the commonly cast metals except magnesium have been produced consistently in these sands. However, difficulty often was experienced in producing bronze castings free of the surface defects known as veining and penetration. These flaws are rarely found when natural sands are used. Veins are extraneous fins of metal which sometimes protrude at various places on the unfinished casting.

Penetration is the name applied

**Veins and penetration are surface defects which frequently occur on castings produced in synthetically bonded sand. They are frequently found on lead and tin bronze castings, and occasionally on iron and steel castings. To find methods for preventing their formation, an investigation was made to determine the mechanism of veining and penetration. Phosphor-bronze was used in experimental work because the defects are most prevalent in castings made with this alloy.**

**Veining of bronze castings is caused by (1) sweating of the metal, which is an extreme case of inverse segregation, and (2) cracking of the mold or core. In the late stages of solidification dissolved gases come out of solution and force the low-melting-point constituent of the alloy toward the surface of the casting through interdendritic passageways. Frequently, this constituent exudes from the surface of the casting and enters cracks in the mold or core to form veins. Cracking of molds and cores is believed to be caused by the thermal expansion characteristics of silica. Penetration defects occur when the exuded metal enters interstices among the sand grains.**

**Elimination of most veining on bronze castings can be accomplished by proper melting practice because this tends to reduce the amount of dissolved gases in the molten metal. Sand techniques which help to eliminate veining by preventing the mold from cracking were developed. Washes containing finely divided refractories stop penetration by filling intertices in the surfaces of molds and cores.**

**The mechanism of veining on gray iron castings is believed to be similar to that of veining on bronze castings, but it is believed that veins on steel castings form only at locations where hot tears occur.**

Presented at a Sand Research Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 8, 1946. Published with permission of the Navy Department without endorsement of statements and opinions of the authors, R. E. Morey and J. R. Kattus, Lt. (j.g.) U.S.N.R., Steel Castings Section, Division of Physical Metallurgy, Naval Research Laboratory, of the Office of Research and Inventions.

to surface roughness produced where molten metal is forced into the interstices between the sand grains for a considerable distance. It varies in severity from slight roughness of the casting surface to extreme cases where the metal has penetrated a distance of an inch or more. These extreme cases, where sand grains are completely surrounded by metal, are frequently called "burnt-on sand."

Preventing the occurrence of these defects is a matter of importance since castings are frequently scrapped because of them or, at best, time and equipment are required to remove them. Therefore, an investigation was conducted to find, if possible, the causes of veining and penetration and means for preventing their occurrence.

*Observations Regarding Veining and Penetration.* While veining has been known to occur in many of the sand casting alloys, the most serious cases are found in certain lead and tin bronzes. Of the ferrous metals, gray cast iron has the greatest tendency to vein, but veins are occasionally found on steel castings. Aluminum and magnesium alloys have the least tendency to form veins.

Veining is often confused with penetration. This confusion arises because the two defects frequently occur simultaneously. However, differences have been noted at the Naval Research Laboratory and also have been recorded in the literature[1].

That molds and cores sometimes crack when suddenly heated is a fact known to most foundrymen. This is attributed to dimensional instability caused by thermal stresses in the sand resulting from temperature gradients. Veins form when molten metal flows into such cracks. They form most frequently at "hot spots" in the sand such as re-entrant angles, but occasionally are found on flat surfaces. Penetration occurs when the metal is fluid enough to flow into interstices between the sand grains.

### Penetration Causes

Coarseness, soft ramming, and poor flowability of the sand are the main causes of penetration. In most cases it may be eliminated by the use of a wash in which a refractory of fine particle size is used as the base. This prevents penetration by filling the interstices between the sand grains but it does not stop the mold from cracking when hot metal is poured into it and hence has little influence on veining. Figure 1 shows a phosphor bronze casting which illustrates this fact. Half of the mold for this casting was painted with silica flour wash and the other half was untouched. The line of demarcation can clearly be seen where penetration was prevented by the wash, but veining was not retarded.

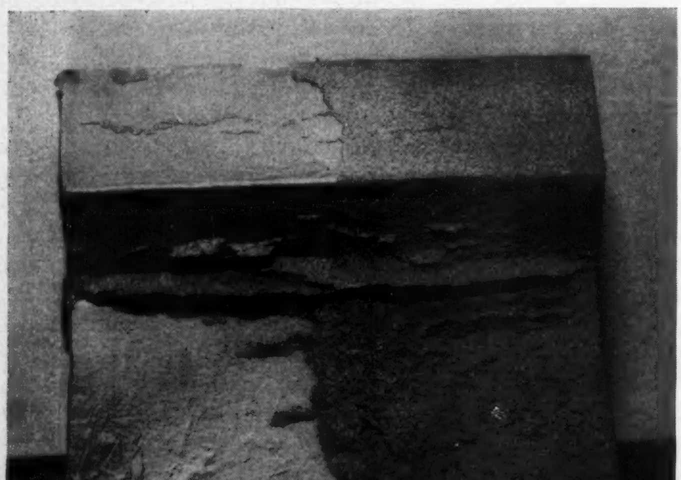


*Fig. 1—Phosphor bronze casting. Left half of mold was painted with a silica flour wash, the other half was not.*

*Suggested Mechanisms of Veining.* No satisfactory explanation of the mechanism which causes veining has ever been proposed. For a crack or fissure to be produced into which metal can flow, the surface of the sand must be in tension. A compressive stress only tends to bond the sand into a more compact mass. When a specimen of rammed sand is heated in a furnace, a temperature gradient exists from the surface to the interior of the body, and the surface expands more rapidly than the interior to produce compression in the surface and tension in the interior.

If the furnace is controlled at some constant temperature below 573° C. (1063° F.), which is the inversion point of alpha quartz to beta quartz, the surface of the specimen comes to the furnace temperature and expands a definite amount. At some later time, the center of the specimen also reaches the furnace temperature and expands an amount equal to the expansion at the surface of the specimen. When this condition is reached, the temperature gradient is gone and the stress gradient also disappears.

Simple heating, therefore, will not produce the necessary tensile stress to cause veining. Conditions existing during cooling can be neglected because it has been observed that, at elevated temperatures, cracks develop in test specimens during the heating period. These facts indicate that some other conditions must exist for veining to occur.

### Granular Sand

Since the sand is a granular material of low strength, it is conceivable that some adjustment takes place in the grain positions or the clay layer which relieves the compressive stress at the surface during the early stages of heating. A temperature gradient then exists with little or no stress gradient, as shown in *C* of Fig. 2. This condition persists as long as the temperature con-

tinues to rise provided the surface does not reach 573° C. (1063° F). However, as the temperature rises the sand is developing hot strength to become a unified mass instead of a granular material.

Then when the sand at the surface reaches a temperature of 573° C. (1063° F.) it suddenly stops expanding and begins to contract slightly, as shown by the expansion curve for sand in Fig. 3, while the sand in the interior of the specimen is still expanding because it has not reached the inversion temperature.

The slight contraction at the surface accompanied by expansion in the center tends to create tensile stresses at the surface. This is believed to be the condition which initiates the cracks which, in a mold, permit the molten metal to enter the sand and form veins. As the isothermal surface at 573° C. (1063° F.) progresses inward, the depth of the crack is gradually increased.

Another suggestion which has been made is that the organic material in the sand mixture burns in a manner similar to that in which a piece of paper contracts when it burns. If a specimen is exposed to an elevated temperature in the dilatometer for a period of not over 4 min. and is then removed and broken open, it will be found that there is a burned or black layer of sand on the surface of the specimen while the center remains unchanged.

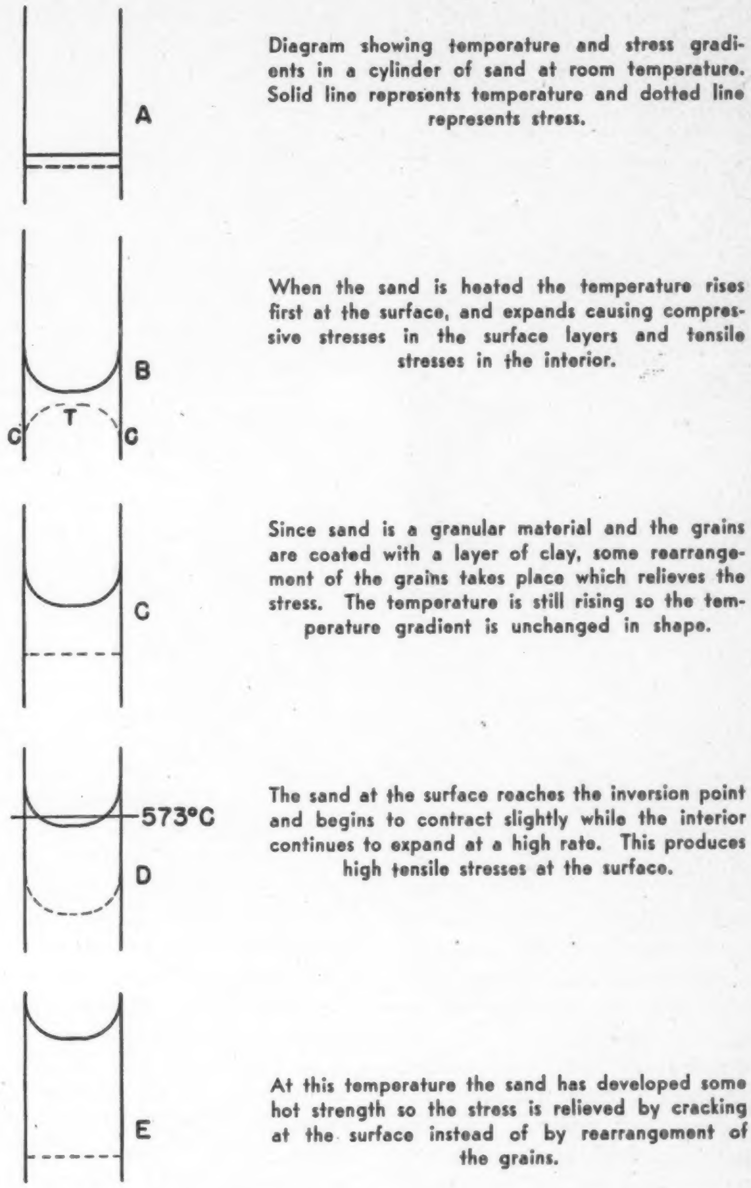



*Fig. 2—Diagram shows temperature and stress gradients in a cylinder of sand.*

### Cracking

This might be expected to cause a change in length of the surface layers and cause some tension which would produce cracking. However, this theory is discredited by tests upon sillimanite and periclase refractories which indicate that the nature of the refractory as revealed by its characteristic curve probably is responsible for the forces which starts cracks in the specimen.

*Experimental Procedure.* Experience in pouring all types of metal at the Naval Research Laboratory has shown that the worst instances of veining are consistently found on phosphor bronze castings. This alloy is known to foundrymen for its property of "attacking the sand." Veining and penetration often disfigure the castings beyond repair. The use of phosphor bronze in experiments on veining produces the most severe test of the sands used; therefore, any means of stopping veining in this alloy would do at least as well as other copper base alloys. For this reason bronze of the following composition was used in all tests: 89.5 per cent copper, 10 per cent tin, and 0.5 per cent phosphorus.

A simple test block (illustrated in Figs. 4 and 5) was designed so that three different sand mixtures could be tested in one casting. Three standard 2x2-in. test specimens,

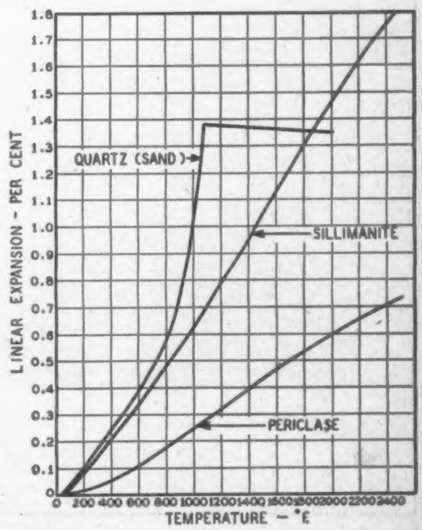



*Fig. 3 (right)—Expansion curves for sand, sillimanite, and periclase.*

*Fig. 4 (top)—Photo shows type of casting used in these tests. Fig. 5 (bottom)—Same as Fig. 4.*

made from three different mixtures, were inserted into the bottom of the mold so that one-half of each specimen projected into the molten metal. This type of test is one of the most severe possible, since the sand under test is nearly surrounded by metal and the heat flow is restricted.

Most mixtures tested were mulled in 2000-gram batches in a 15-lb. capacity laboratory muller. The regular molding sand and core sand, which were used for the purpose of comparison, were taken from sand bins in the foundry after they had been mulled in a 200-lb. production muller. Specimens made of clay-bonded molding sands were dried at 105° C. (220° F.), and those made of core sands were baked at their normal baking temperatures before being placed in test molds.

### Induction Furnace Used

All heats were melted in an induction furnace. After the data from each heat were recorded, the same metal was remelted for use in subsequent tests.

*Test Results.* If the first possible mechanism stated in the foregoing is a valid explanation for the cracks which form on mold surfaces as their temperatures are raised, refractories which have smooth expansion curves should be free from cracks and thus prevent veining when used as molding materials. Two such materials, namely, periclase (MgO) and sillimanite ($Al_2O_3.SiO_2$) were tested. Their expansion curves are shown in Fig. 3. Samples of sand and of these materials having equivalent particle size were bonded similarly and tested in experimental castings. Figure 6 shows the results obtained. From left to right the cores were sand, sillimanite, and periclase. Both periclase and sillimanite stopped veining completely; thus the foregoing theory is given support.

Ability of periclase and sillimanite to undergo shock heating without cracking is illustrated in Fig. 7. These three dilatometer specimens were subjected to a temperature of 1093° C. (2000° F.) for a period of 3 min. Both periclase and sillimanite maintained smooth, continuous surfaces, but large cracks were developed in the sand. The specimens all had been coated with silica wash in order to show the cracks more clearly. Most of the sand mixtures used in these experiments were subjected to this test. It was found that, in general, the degree of veining of the test casting was related to the amount of cracking developed by the shock-heating test.

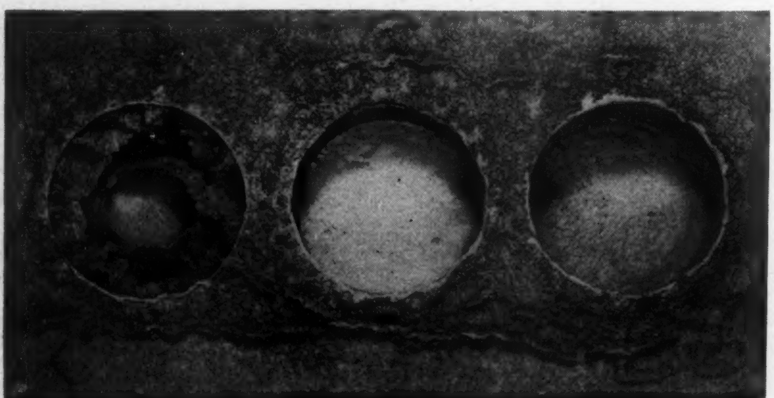


*Fig. 6—Test casting shows results produced by test cores of (left to right) sand, sillimanite and periclase.*

Earlier in this paper it was stated that veining is most serious in lead and tin bronzes, while other metals show much less tendency to form veins. From some heats of lead and tin bronzes, castings are made which are free from veins, although the chemical composition and pouring temperature apparently are the same as those of similar heats from which castings with many veins are produced. This indicates the existence of some property characteristic of each heat which determines whether or not veining occurs.

Early in these experiments it was noted that in most heats the phenomenon of tin sweating occurred. Sweating is an extreme case of inverse segregation in which the low melting point constituent of an alloy exudes from the surface of the casting late in solidification. Figure 8 shows a typical example of tin sweat which has exuded from the top of a riser. The fact was soon established that the serious cases of veining are associated with this phenomenon because invariably the heats that sweated were the ones in which the bad cases of veining occurred. Two castings which illustrate this fact are shown in Figs. 9 and 10.

In both cases the chemical compo-

*Fig. 7—Test cores after being subjected to a shock heat test of 2000° F.*

**Table 1**

COMPOSITION OF VEIN, EXUDED METAL, AND BODY OF CASTING

| | Composition, per cent — Cu | Sn | P |
|---|---|---|---|
| Veins | 84.2 | 14.3 | 1.5 |
| Exuded Material | 79.0 | 17.3 | 2.0 |
| Body of Casting | 89.8 | 10.3 | 0.6 |

sition of the heats, pouring temperature, and type of molding sand were the same. The tin sweat in the casting shown in Fig. 9 was pronounced, while in the casting shown in Fig. 10 it was completely absent. It will be noted that veining in the casting which sweated is many times worse than in the one in which sweating did not occur.

### Veining and Sweating

In order to further associate veining with sweating, a sample of material which was exuded from the top of a riser and actual veins which were chipped from castings were analyzed. The results, given in Table 1, show that both the veins and the exuded material are high in tin and phosphorus and, therefore, are low-melting-point constituents.

As a final experiment to prove that sweating is responsible for veining, two identical castings were poured from the same heat. One was shaken from the mold 4 min. after pouring, and the other was allowed to cool in the mold. The casting which was removed from the mold while hot had solidified sufficiently to retain its shape, but no veins had formed. However, shortly thereafter, sweating began to

*Fig. 8—Top of riser shows low-melting constituent which has exuded (tin sweat).*

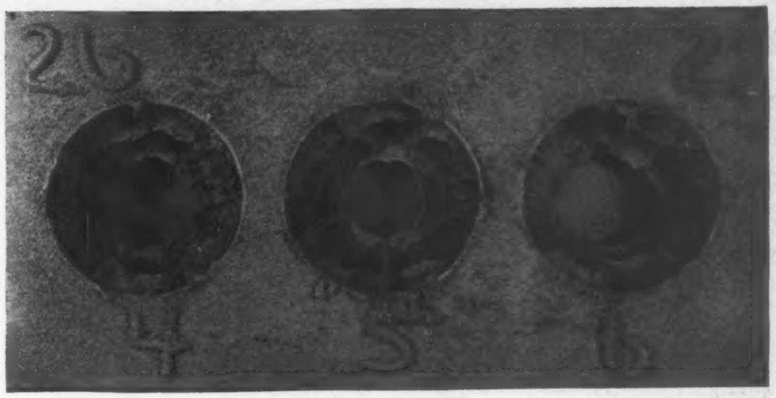


*Fig. 9—Phosphor bronze casting on which tin sweat was pronounced; veining associated with this phenomenon.*

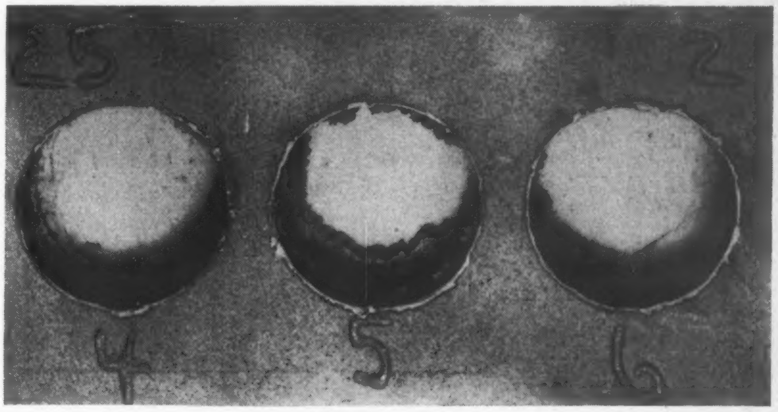


*Fig. 10—Phosphor bronze casting on which tin sweat was absent.*

take place with liquid metal exuding from numerous places on the casting. The casting that cooled in the mold formed many veins. These castings are shown in Figs. 11 and 12.

### Sweat Beads

Many beads of sweat are visible on the casting shown in Fig. 11, which was shaken out while hot. The obvious conclusion may be drawn that metal also exudes from the casting shown in Fig. 12 but, having no other place to go, was forced into cracks in the sand and thus formed veins. It may be noted that the surface of the bottom casting is much rougher than that of the top casting. Thus it appears that the exuded metal also enters interstices among the sand grains and causes penetration.

Many theories have been proposed to explain inverse segregation[6,7,12]. Data obtained in these experiments on phosphor bronze support that of Gender[7], who states that gases which are dissolved in the liquid metal come out of solution during the later stages of solidification and force the low-melting-point constituent toward the surface through interdendritic passageways.

Density determinations were made on six test castings from different heats, three of which sweated and veined whereas the other three did not. The chemical composition, pouring temperature, and position of the samples for density determina-

**Table 2**

DENSITY DETERMINATIONS

| Density, grams per cc. — Castings with tin sweat | Castings with no tin sweat |
|---|---|
| 7.974 | 8.351 |
| 8.165 | 8.375 |
| 7.975 | 8.329 |

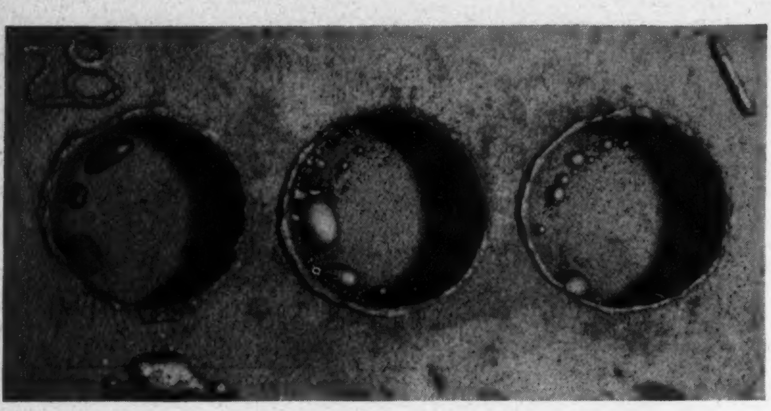


*Fig. 11—Casting shaken out from mold 4 min. after it was poured. Note globules of sweated metal but absence of veining.*

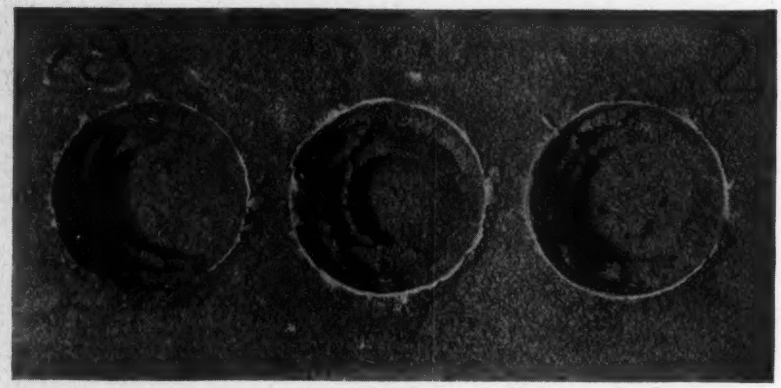


*Fig. 12—Casting from same heat as casting in Fig. 11; cooled overnight in the mold before shaking out. Note veining but absence of globules of sweated metal.*

tion were the same for each test.

Results given in Table 2 show that the castings which sweated and veined are considerably less dense. This can be attributed only to entrapped gases; therefore, it appears that at least for the extreme case of inverse segregation known as sweating, Gender's theory is valid.

The fact that severe cases of veining generally are found on lead and tin bronze castings can be readily explained by the theory of sweating. These alloys have wide freezing ranges, which is a condition that must exist in order for sweating to occur. This condition promotes the type of freezing in which coring and dendritism are prominent. When freezing progresses in this manner, numerous interdendritic passages form, through which the low-melting point constituent can flow to the surface.

*Veins on Gray Iron and Steel Castings.* It is possible that the theory of sweating also explains the veins which frequently are found on gray iron castings. This alloy has a wide freezing range, and research conducted at the Naval Research Laboratory indicates that its manner of freezing is similar to that of tin bronzes; i.e., during the initial stages of solidification, many dendrites form throughout the casting with liquid metal filling the interstices. Although the amount of gas dissolved in cast iron may be negligible, a phenomenon occurs which might have a similar effect in causing sweating. This is the formation of graphite flakes. It is conceivable that the growth of the flakes forces liquid metal to the surface in the same way that the rejection of dissolved gases causes sweating bronzes.

Veins occasionally occur on steel castings, but they differ from those found on bronze castings in both appearance and location. They are small and seldom occur at re-entrant angles. Because of the narrow solidification range of steel, its manner of solidification differs from that of tin bronzes and cast iron.

Instead of the formation of dendrites throughout the casting, the solidification of steel begins with the formation of a solid skin of metal in contact with the mold and progresses inward with a relatively sharp division between the solidified layer and the liquid metal. For these reasons, sweating and inverse segregation do not occur in steel, and veins must form by some other mechanism.

### Bore Cracks

Studies of bore cracks, hot tears of a specific type, found in cast steel fittings and valve bodies[11], show that veins on steel castings frequently are found following the contour of these cracks. Experimental observations led to the explanation that hot tears form in the solid skin of metal while the interior of the casting is liquid. The sand adjacent to the casting adheres to the metal and also tears. Molten metal from the interior of the casting flows through the crack in the solid skin and into the adjacent crack in the sand to form a vein. The problem of eliminating veins on steel castings, therefore, is secondary to the problem of eliminating hot tears. If the proper precautions to prevent hot tears are observed, no veining occurs.

Evidence indicating that this theory of veining is applicable to bronzes is lacking. The experiment in which a test casting was shaken out 4 min. after being poured precludes this possibility. One of the necessary conditions for the formation of hot tears in steel castings is friction between the sand and the casting. There were no exudations from the surface of this casting until it had been out of the mold for a minute and, therefore, the casting was free of any frictional stresses imposed by the sand.

It is, therefore, reasonable to conclude that the cause of exudations was not hot tearing. The exudations, which took place in this experiment, occurred at numerous scattered points, and it is not likely that they were connected by cracks. Microscopic and macroscopic examinations revealed no cracks in the vi-

cinity of veins on the bronze castings.

*Prevention of Veining by Proper Melting.* The evidence indicating that the formation of veins on bronze castings is one of the effects of sweating and that this is caused by gassiness makes it apparent that melting practice is an important factor to be considered. If gases can be excluded from the melt, veins seldom are formed.

## Cast Bronze Research

Melting practice and gas porosity of cast bronzes have been the subjects of much research[8,9,10]. Although there was no systematic investigation of them made during these experiments, the results obtained suggest a few of the principles that should be followed to obtain good castings:

1. Heats of virgin metals should be melted, allowed to solidify, and then remelted before being cast. In general, heats made from pig or scrap are less gassy than those melted from virgin metals.

2. The use of clean, high grade raw materials is desirable.

3. An oxidizing atmosphere is best for melting.

4. If deoxidation is necessary, the minimum amount of deoxidizer should be used and it should be added just before pouring.

5. The temperature of the melt should be kept as low as is practical. The maximum temperature reached rather than the pouring temperature is most critical. Gas solubility increases with temperature, therefore the highest temperature attained determines the amount of gas dissolved. As the temperature falls, dissolved gases do not come out of solution until sufficient time elapses for equilibrium to be established. Most of the gas dissolved during melting is retained in the metal until solidification is in progress.

*Influence of the Sand Mixture on Veining.* Although it has been shown that sweating is responsible for the serious cases of veining, it is also true that the mold or core must crack before veins can form; therefore, the condition of the sand is an important factor in veining. Numerous sand mixtures were tested with experimental castings. It should be remembered that the test was one of the most severe possible.

The metal used has a greater tendency than any other to form veins;

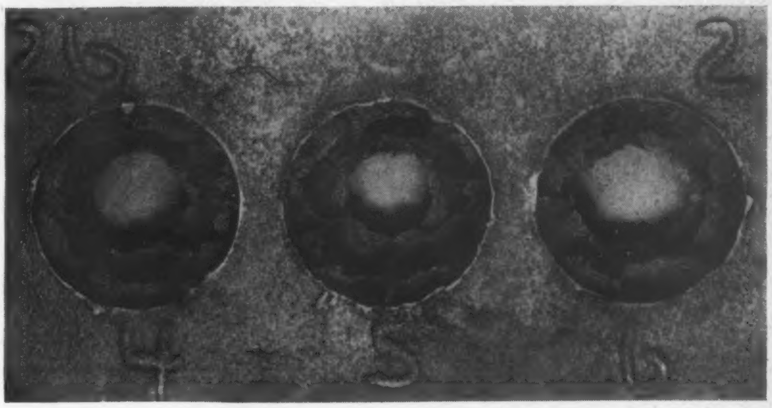


*Fig. 13—Effect of different amount of core ramming.*

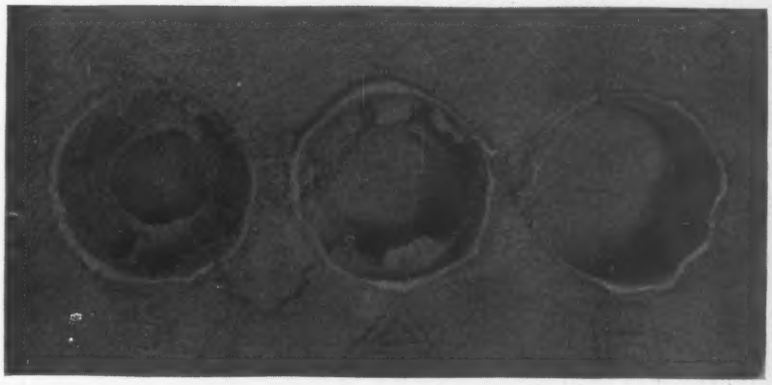


*Fig. 14—Veining can be decreased by use of fine sand.*

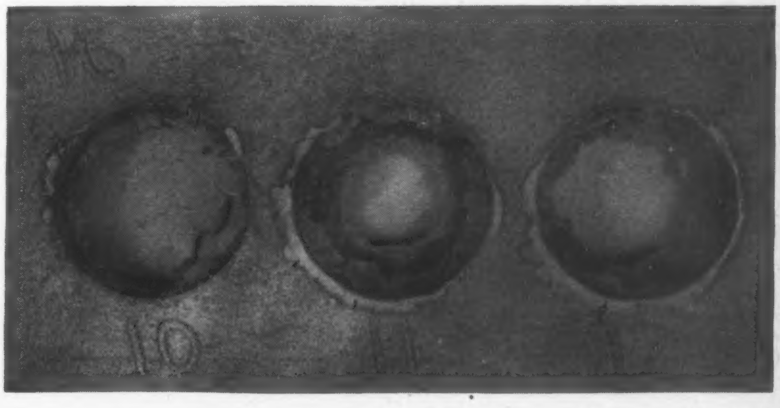


*Fig. 15—Test casting shows effect of sand grain distribution.*

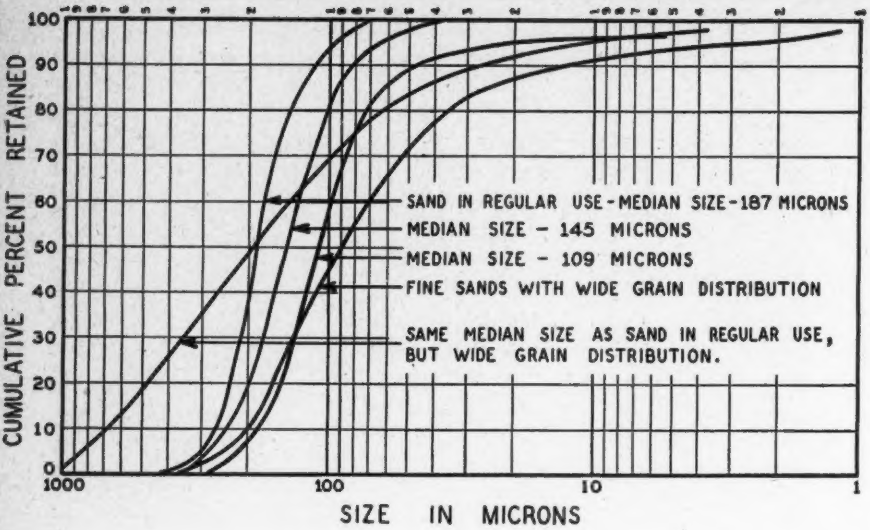



*Fig. 16—Cumulative curves of sands used for castings shown in Figs. 14 and 15.*

no attempt was made to employ the best melting procedure, and the shape of the test casting is one with which veins may be formed easily. Any conditions which are effective for preventing the formation of veins should be even more effective under less severe conditions. Most of the test cores were painted with silica wash in order to eliminate penetration so that the veining could be clearly seen. The pouring temperature in all tests was 2000° F.

*Ramming.* The effect of different amounts of ramming is negligible. This is illustrated in Fig. 13, which shows a casting in which three cores of molding sand were rammed differently. Cores No. 4 and 5 (as marked on the casting) were rammed ten times and one time, respectively, while No. 6 was made by ramming ¾ of its length nine times, then adding the remainder of the sand and ramming once again in order to form an unevenly rammed specimen.

*Grain Fineness and Distribution.* Veining can be decreased by the use of fine sand. This is shown in Fig. 14. The three cores used in this casting were molding sands with median sizes of 187, 145, and 109 microns, respectively, from left to right. These sizes are approximately equivalent to A.F.A. grain fineness numbers 80, 108, and 135.

Core No. 10 in Fig. 15 was a fine synthetic molding sand with a wide grain distribution; No. 11 was the regular molding sand which has a well assorted grain distribution; and No. 12 has the same median size but a wide grain distribution. The wide distribution gives slightly better results. Cumulative curves for these sands are shown in Fig. 16.

*Facing Materials.* Numerous facing materials and binders were tested. No correlation was found between any of the ordinary physical properties of molding sands and the degree of veining. However, one property which has a great influence on veining was discovered. This is the property of plasticity at elevated temperatures. Certain materials, when added to the sand mix, render a rammed body of the sand capable of being deformed at high temperatures without breaking. This enables the thermal stresses in the sand to relax by plastic deformation rather than by cracking, and hence prevents veining.

## Wood Flour

The best material which has been found for imparting plasticity at elevated temperatures is wood flour, but it is useful only when employed in conjunction with a clay such as bentonite. It can not be used with success in core sands. Apparently, there is a fluxing reaction between the wood and the clay which produces plasticity. Wood flour increases collapsibility and ease of shake-out, but it creates gas and lowers dry strength.

Other materials which produce this property in sand are ordinary fluxes such as borax or sodium carbonate. However, these materials flux directly with the sand and produce a hard glass which makes shake-out and cleaning difficult. They also increase penetration.

In Fig. 17, the left-hand and center cores consisting of regular molding sand with additions of 5 per cent wood flour and borax, respectively, are compared with one made of regular molding sand with no additions. Some penetration can be seen where the core mixture containing borax was used, but veining was stopped completely by both wood flour and borax.

## Hot Compression

The property of plasticity can best be investigated by means of a hot compression test. This consists of compressing a dilatometer specimen after soaking at temperature for 12 min. Ordinarily the specimen remains relatively rigid until a certain load is reached, and then it collapses into two or more pieces. However, mixtures containing wood flour, borax, sodium carbonate or other fluxing materials begin to flow plastically when a small load of a few psi. is applied. Thereafter, the load remains constant while the specimen is compressed to a shape with shorter length and increased diameter.

The load required to produce plastic flow and the extent to which the specimens can be compressed without cracking or breaking depends on the type of flux, soaking time, and temperature. If specimens made from mixtures containing 5 per cent borax or wood flour are heated to 2000° F. or above for 12 min., they can be compressed to less than three-quarters of their original lengths without cracking.

Other organic materials such as activated charcoal and sea coal were tested. Their influence on the sand mixture is similar to that of wood flour in that they make it possible for the dilatometer specimen to be compressed without complete failure, but they do not maintain smooth, uncracked surfaces. These materials were not as effective in preventing veining as those previously mentioned. The fact that sea coal imparts plasticity to the sand at elevated temperatures may be a clue to its usefulness in iron molding sands.

*Washes With Low Fusion Points.* Experience in casting steel has shown that a thin layer of the mold directly in contact with the metal

becomes viscous within a few seconds after pouring and, upon cooling, forms a glaze. When properly controlled, this glaze may be easily peeled from the casting and is instrumental in producing a smooth surface. This condition is not achieved in non-ferrous castings because of the wide difference between the pouring temperature of the metal and the fusion point of the sand.

As a possible means of preventing the formation of veins, such glazes were produced with bronze castings by the use of low-fusion-point washes. These washes were made in three ways; frits of ceramic materials, combined in such a way to have a fusion point 1800° F., were employed as the base material in a wash; silica flour wash was adulterated with fluxes such as sodium carbonate, borax, and potassium nitrate in order to lower its fusion point; and plain water solutions of such fluxes were applied to the surface of the mold.

### Eliminating Veining

Ceramic frits were only slightly beneficial. Adulterated silica washes did not stop veining entirely, but were superior to the washes which contained ceramic frits. Only the method of applying water solutions of fluxes to the mold was completely effective in eliminating veining.

The reason for the superiority of this type of wash over the adulterated silica wash is its ability to penetrate further into the mold. If the water to silica ratio of the adulterated silica wash is increased it is more effective for preventing veins since it penetrates more deeply into the sand.

In Fig. 18, the left and center cores were molding sand, painted with a 12 per cent water solution of sodium carbonate. The center cores were of molding sand, painted with a 12 per cent water solution of sodium carbonate. The center core had, in addition, a coating of silica wash applied after the sodium carbonate solution was dried. On the right is the same sand covered only with silica wash.

No veins were formed in the core washed with a plain sodium carbonate solution. On the core which was coated with silica was in addition to a solution of sodium carbonate, a smoother surface was pro-

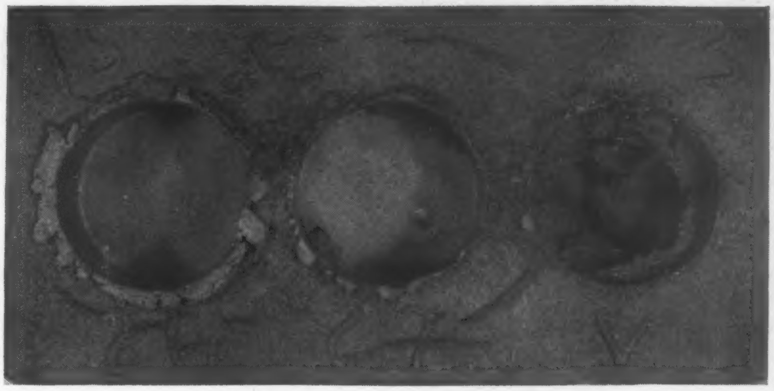


*Fig. 17—Effect of sands with wood flour and borax additions compared with regular molding sand.*

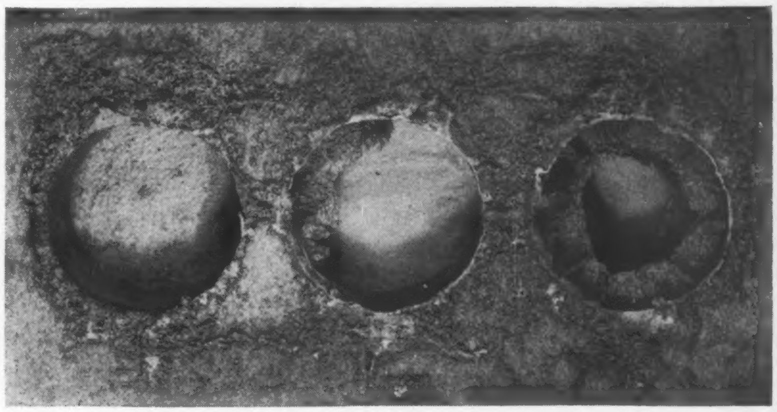


*Fig. 18—A comparison of washes of a solution of sodium carbonate, silica flour over sodium carbonate, and regular silica flour.*

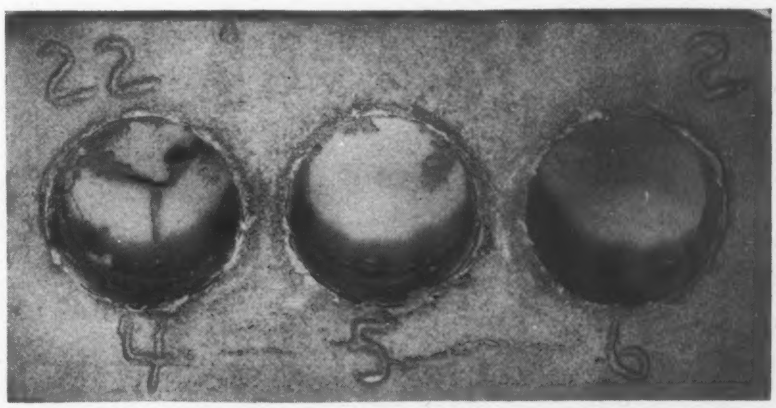



*Fig. 19—Casting shows the effect of using molding sands containing 1 per cent, 3 per cent, and 10 per cent bentonite with no cereal binders.*

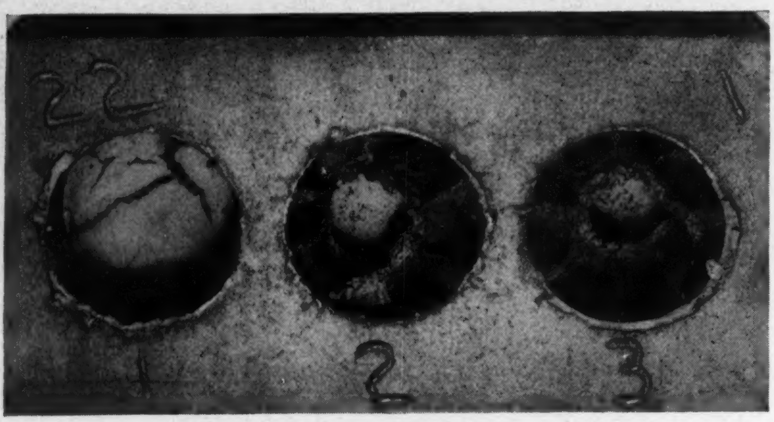



*Fig. 20—Casting shows the effect of core sands with increasing amounts of core oil and corn flour.*

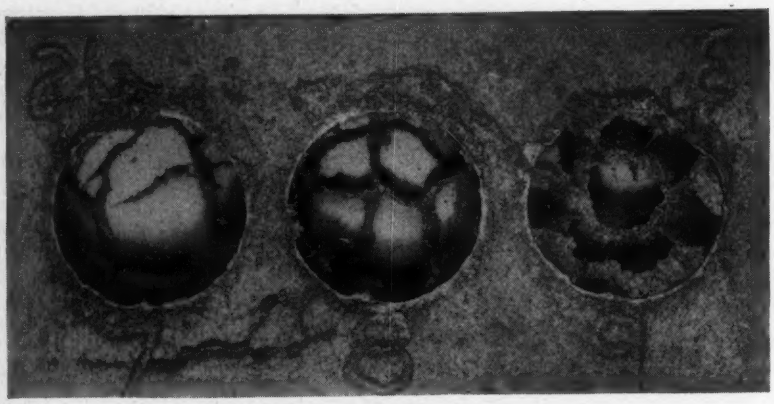


*Fig. 21—Photo shows effect of cores containing a resin binder as compared with cores made with regular core sand.*

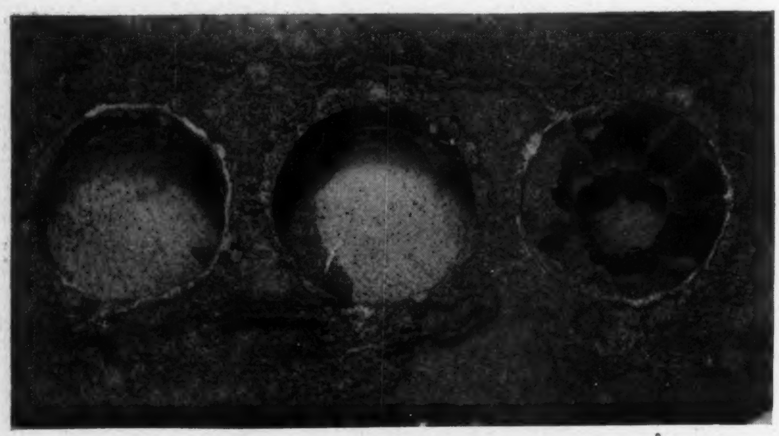


*Fig. 22—A comparison of cores of the same composition mixed by different methods.*

duced but a small vein was formed. The core at the right shows the normal condition of veining for the sand.

All of the low-fusion-point washes formed glazed coatings on the casting; but, rather then peeling off easily as with steel castings, they adhered tightly to the castings and were difficult to remove.

*Clay Content of Molding Sands.* Veining occurs more readily in sands bonded with both cereal and clay binders than it does in sands bonded with clay alone. For this reason and because of the fineness, wide grain distribution, and low fusing point of natural sands, the occurence of veins in such sand is rare.

### Bentonite Addition

Fig. 19 shows a casting in which regular 180-micron base sand was bonded only with water plus one per cent, 3 per cent and 10 per cent bentonite, respectively, from left to right. The veining is decreased as the bentonite is increased.

*Core Sands.* The information obtained on core sands used in these experiments shows that a minimum of veining occurs when the more collapsible cores are used. It is believed that veining will not occur in cores which collapse before sweating begins because cracks in such cores are filled with loose sand. Evidence to support this theory is shown in Figs. 20, 21, and 22. In Fig. 20, a photograph of a casting is shown in which all cores were bonded with core oil and corn flour: No. 1 contained 0.5 per cent of each, No. 2 was the regular core sand with 1.0 per cent of each, and No. 3 had 2.5 per cent of each binder. Core No. 1 apparently had collapsed before sweating commenced, while the other two had not. Two cores bonded with a collapsible resin binder are compared with one containing the regular binders in Fig. 21. Core No. 7 contained 1.0 per cent resin; core No. 8, 1.0 per cent resin plus 0.5 per cent dextrine; and core No. 9 was composed of regular core sand. It is well known that quick collapsibility is a characteristic of all cores bonded with resin binders. This property probably is responsible for the appreciable reduction in veining which results from the employment of resinous core binders.

A final illustration of the effect of collapsibility is shown in Fig. 22. All

the cores used in this casting contained the ingredients of regular core sand, but they were mixed differently. The one on the left was mixed in 200-gram batches by hand and the one in the center by means of a mortar and pestle, while the righthand core was made from a batch mixed in the production muller. In both the poorly mulled cores veining was eliminated, probably because they were loosely bonded and collapsed soon after pouring.

### Conclusions

Severe cases of veining in bronzes are caused by cracking of the mold due to thermal stresses and subsequent sweating of the metal. The elimination of either of the two causes is sufficient to stop or greatly reduce the occurrence of veining. Sweating is caused by gas evolution from the solidifying metal and may be eliminated by proper melting practice. The best methods found for reducing cracking of the mold are the following:

*a.* The use of the fine sand with a wide grain-size distribution.

*b.* The addition of wood flour to the molding sands.

*c.* Washing of molds and cores with a water solution of a flux such as sodium carbonate.

*d.* The use of as little organic binder as is practical.

*e.* The use of as collapsible cores as is possible.

Veins on gray iron castings are believed to form in a manner similar to that of vein formation on bronze castings except that the internal pressure is produced by the growth of graphite flakes instead of gases evolved from the metal.

Veining defects on steel castings are less prevalent than on bronze castings. They occur as a result of hot tears which are caused by stress conditions within the mold. Elimination of veining under these conditions is primarily a problem of preventing the formation of hot tears.

Prevention of penetration can be accomplished simply by applying a silica flour mold wash to those areas in which the penetration usually occurs.

### Bibliography


1. J. B. Caine, "A Study of Adhering Sand," TRANSACTIONS, American Foundrymen's Association, vol. 51, pp. 677-705, (1943). Note particularly discussion on pp. 698-699.

2. R. B. Sosman, *The Properties of Silica,* The Chemical Catalog Co., Inc. (1926), Chap. XX, pp. 360-415.

3. L. H. Adams and E. D. Williamson, "The Annealing of Glass,," *Journal,* Franklin Institute, vol. 190, pp. 590-631 (1921).

4. E. A. Rominski and H. F. Taylor, "Stress Relief and the Steel Casting," TRANSACTIONS, American Foundrymen's Association, vol. 51, pp. 709-731 (1943).

5. R. A. Heindl, "The Thermal Expansion of Refractories to 1800° C.", Bureau of Standards, *Journal of Research,* vol. 10, pp. 715-735 (1933).

6. N. B. Vaughn, "Inverse Segregation: A Review," *Journal,* Institute of Metals, vol LXI, pp. 35-60 (1937).

7. R. Gender, "The Mechanism of Inverse Segregation in Alloys," *Journal,* Institute of Metals, vol. 37, pp. 241-267 (1927).

8. F. W. Rowe, "Studies in Cast Bronze," *Foundry Trade Journal,* vol. 50, pp. 363 (1934).

9. R. F. Person and W. A. Baker, "Causes of Porosity in Tin Bronze Castings," *Journal,* Institute of Metals, vol. 67, pp. 231 (1941).

10. G. L. Bailey, "Porosity in Non-Ferrous Metal Castings," *Foundry Trade Journal,* vol. 50, pp. 175 (1934).

11. H. F. Taylor, H. F. Bishop and W. H. Johnson, "Studies on the Causes and Methods of Preventing Bore Cracks in Cast Steel Fittings and Valve Bodies," NRL Report M-2637 (1945) and Preprint No. 46-7, American Foundrymen's Association (1946).

12. R. M. Brick, "Fundamental Principles in Segregation in Alloy Castings," AIME, *Metals Technology,* Sept., 1944, vol. 11, no. 6.


## Ferrous Parts Cleaned With Hydride Solution

APPLICATION OF the sodium hydride immersion process to descaling and desanding gray iron castings is reported successfully undertaken by a midwestern manufacturer of oil-pump bodies.

Chemical modification of scale and even such refractory material as sand is said to be accomplished through action of sodium hydride, present in the sodium hydroxide bath in which parts are immersed. A powerful reducing agent, sodium hydride acts to remove oxygen from any compounds adhering to castings; so that, as a result of the modification, they may be removed in subsequent washing operations.

Set-up used in the case described is quite simple. Work is immersed in the molten caustic soda bath, held at temperature of approximately 700° F. in a furnace employing the well known immersed-electrode heating principle. Vigorous stirring action, tending to maintain uniformity of heat, is created by electromagnetic forces within the bath as a result of grouping and design of electrodes. Sodium hydride is produced within the solution itself by chemical reaction of sodium and hydrogen.

*(Photo courtesy Ajax Electric Co. Inc.)*

*Lowering a batch of gray iron castings into a sodium hydride bath, at approximately 700° F., for descaling and degreasing. Unit, with solution heated by two pairs of closely-spaced electrodes (at right), has gross capacity of 1250 lb. per hour.*

After a quench in water at room temperature, which should remove loosened material and caustic, work is rinsed in water at the same temperature. At this point a dilute sulphuric acid dip of no more than one minute may be used, although little cleaning is accomplished thereby.

Final step is immersion in a weak sodium cyanide solution at 200° F., to neutralize any acid remaining on work surface and provide protection against corrosion.

Equipment necessary for the process is said to require little space, and be suitable for inclusion in a production line as a completely mechanized unit with one or two operators for loading and unloading.

## Foundry Plant Planned

CONTEMPLATING PRODUCTION by May of next year, Attwood Iron Industries, Inc., Grand Rapids, Mich., has announced proposed construction of a $200,000 foundry plant, with Associated Engineers, Ft. Wayne, Ind., assigned to draw up plans. Principals in the foundry business are C. H. Attwood, president, Attwood Brass Works, Grand Rapids, and others of that firm.

## THE CUPOLA HANDBOOK

*(Continued from page 52)*

T. L. Arzt Foundry Co., Chicago, Ill.
The Atlantic Foundry Co., Akron, Ohio
Atlas Foundry Co., Detroit, Mich.
B. B. Foundry, Ltd., Berkeley, Calif.
Baker Perkins Co., Inc., Saginaw, Mich.
Bassett Foundry Co., Adrian, Mich.
Bauer-Wilson & Bateman, Chicago, Ill.
M. A. Bell Co., St. Louis, Mo.
T. H. Benners & Co., Birmingham, Ala.
Berted Foundry Co., Columbiana, Ohio
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Blackmer Pump Co., Inc., Grand Rapids, Mich.
The Bostick Foundry Co., Lapeer, Mich.
Brillion Iron Works, Inc., Brillion, Wis.
The Brown-Fayro Co., Johnstown, Pa.
Brown Industries, Inc., Sandusky, Ohio
Edward G. Budd Mfg. Co., Detroit, Mich.
Buick Motor Div., General Motors Corp., Flint, Mich.
Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo.
Cadillac Motor Car Div., Detroit, Mich.
Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Edwin S. Carman, Inc., Engineers, Cleveland, Ohio
Carondelet Foundry Co., St. Louis, Mo.
Carpenter Brothers, Inc., Milwaukee, Wis.
Central Foundry Co., Holt, Ala.
Central Iron Foundry Co., Detroit, Mich.
Central Specialty Co., Ypsilanti, Mich.
Certified Core Oil & Mfg. Co., Chicago, Ill.
Chain Belt Co., Milwaukee, Wis.
Chamberlain Co., Oakland, Calif.
Chevrolet Grey Iron Foundry, Div. GMC, Saginaw, Mich.
Chicago Foundry Co., Des Plaines, Ill.
Chicago Retort & Fire Brick Co., Chicago, Ill.
Chrysler Corp., Dodge Div., Hamtramck, Mich.
City Foundry Co., Cleveland, Ohio
Cleveland Quarries Co., Cleveland, Ohio
Climax Molybdenum Co., New York, N. Y.
The Clover Foundry Co., Muskegon, Mich.
James B. Clow & Sons, Chicago, Ill.
Continental Gin Co., Birmingham, Ala.
Continental Roll & Steel Foundry Co., East Chicago, Ind.
Crane Co., Chicago, Ill.
Crouse-Hinds Co., Syracuse, N. Y.
Crown Iron Works, Minneapolis, Minn.
Cummings-Moore Graphite Co., Detroit, Mich.
Darbyshire-Harvie Iron & Machine Co., El Paso, Texas
Deere & Co., Moline, Ill.
Delco-Remy Div., General Motors Corp., Anderson, Ind.
Del Monte Properties Co., Del Monte, Calif.
Delta Oil Products Co., Milwaukee, Wis.
Detroit Brass & Malleable Works, Detroit, Mich.
Detroit Edison Co., Detroit, Mich.
Detroit Gray Iron Foundry Co., Detroit, Mich.
Detroit Steel Casting Co., Detroit, Mich.
The East Akron Casting Co., Akron, Ohio
East St. Louis Castings Co., East St. Louis, Ill.
Eastern Clay Products, Inc., Detroit, Mich.
Eaton Mfg. Co., Foundry Div., Detroit, Mich.
Electric Wheel Co., Quincy, Ill.
Electro Metallurgical Co., New York, N. Y.
Elkhart Foundry & Machine Co., Elkhart, Ind.
Elyria Foundry Div., Indus. Brownhoist Corp., Elyria, Ohio
Enot Foundry Co., Wayne, Mich.
Enterprise Engine & Foundry Co., San Francisco, Calif.
Fairmont Railway Motors Co., Fairmont, Minn.
Fanner Mfg. Co., Cleveland, Ohio
The Fate-Root-Heath Co., Plymouth, Ohio
Fearon Foundry Co., Chicago, Ill.
Federal Foundry Supply Co., Detroit, Mich.
The Ferro Machine & Foundry Co., Cleveland, Ohio
Stanley G. Flagg & Co., Philadelphia, Pa.
Florence Pipe Fdry. & Machine Co., Florence, N. J.
Ford Motor Co., Dearborn, Mich.
Foundries Supply & Sales Co., Milwaukee, Wis.
The Foundry Equipment Co., Cleveland, Ohio
The Foxboro Co., Foxboro, Mass.
Frank Foundries Corp., Moline, Ill.
French & Hecht, Inc., Davenport, Iowa
Frick Co., Waynesboro, Pa.
Fulton Foundry & Machine Co., Inc., Cleveland, Ohio
The G. & C. Foundry Co., Sandusky, Ohio
Gale Mfg. Co., Albion, Mich.
General Foundry & Mfg. Co., Flint, Mich.
General Malleable Corp., Waukesha, Wis.
General Metals Corp., Oakland, Calif.
General Refractories Co., Philadelphia, Pa.
Walter Gerlinger, Inc., Milwaukee, Wis.
Gibson & Kirk Co., Baltimore, Md.
Gilson, J. E. & Co., Port Washington, Wis.
Glamorgan Pipe & Foundry Co., Lynchburg, Va.
Globe Iron Co., Jackson, Ohio
Gould Pumps, Inc., Seneca Falls, N. Y.
Grand Rapids Foundry, Div. Oliver Mach. Co., Grand Rapids, Mich.
Great Lakes Foundry Sand Co., Detroit, Mich.
Grede Foundries, Inc., Wauwatosa, Wis.
A. P. Green Fire Brick Co., Mexico, Mo.
Green Foundry Co., St. Louis, Mo.
Griffin Wheel Co., Chicago, Ill.
Gunite Foundries Corp., Rockford, Ill.
Hansell-Elcock Co., Chicago, Ill.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Hardinge Mfg. Co., York, Pa.
Hart-Carter Co., Minneapolis, Minn.
Hickman, Williams & Co., Cleveland, Ohio
Hill & Griffith Co., Cincinnati, Ohio
R. Hoe & Co., Inc., Dunellen, N. J.
Hoffman Foundry Supply Co., Cleveland, Ohio
The Hydro-Blast Corp., Chicago, Ill.
Hyman-Michaels Co., Chicago, Ill.
Indiana Gas & Chemical Corp., Terre Haute, Ind.
Industrial Castings Co., Detroit, Mich.
Industrial Equipment Co., Minster, Ohio
Ingersoll-Rand Co., Painted Post, N. Y.
Inland Lime & Stone Co., Manistique, Mich.
International Harvester Co., Chicago, Ill.
International Nickel Co., Inc., New York, N. Y.
Ironton Fire Brick Co., Ironton, Ohio
Iroquois Foundry Co., Racine, Wis.
Jackson Iron & Steel Co., Jackson, Ohio
Jamestown Iron Works, Inc., Jamestown, N. Y.
Jamestown Malleable Iron Corp., Jamestown, N. Y.
M. S. Kaplan Co., Chicago, Ill.
Kelsey Hayes Wheel Co., Detroit, Mich.
The Kennedy Valve Mfg. Co., Elmira, N. Y.
The Kindt-Collins Co., Cleveland, Ohio
Kohler Co., Kohler, Wis.
Koppers Co., American Hammered Piston Ring Div., Baltimore, Md.
Koppers Co., Minnesota Div., St. Paul, Minn.
The Laclede Gas Light Co., St. Louis, Mo.
LaGrange Iron Works, LaGrange, Ill.
Lake Erie Foundry Co., Buffalo, N. Y.
Lakey Foundry & Machine Co., Muskegon, Mich.
W. O. Larson Foundry Co., Grafton, Ohio
Laurel Machine & Foundry Co., Laurel, Miss.
Leeds & Northrup Co., Philadelphia, Pa.
Liberty Foundry Co., St. Louis, Mo.
Lindgren Foundry Co., Batavia, Ill.
Link Belt Co., Chicago, Ill.
Little Bros. Foundry Co., Port Huron, Mich.
Love Brothers, Inc., Aurora, Ill.
Lufkin Foundry & Machine Co., Lufkin, Texas
Lynchburg Foundry Co., Lynchburg, Va.
M & M Gray Iron Foundry, Waupun, Wis.
Mabry Foundry & Machine Co., Beaumont, Texas
Mack Mfg. Corp., New Brunswick, N. J.
The Manufacturers Foundry Co., Waterbury, Conn.
Marion Malleable Iron Works, Marion, Ind.
Mathieson Alkali Works, Inc., New York, N. Y.
J. S. McKesson, Lakewood, Ohio
McWane Cast Iron Pipe Co., Birmingham, Ala.
Meech Avenue Foundry, Cleveland, Ohio

Menomonee Falls Mfg. Co., Menomonee Falls, Wis.
Mexico Refractories Co., Mexico, Mo.
Michigan Alkali Co., Detroit, Mich.
Michigan Malleable Iron Co., Detroit, Mich.
Michigan Steel Casting Co., Detroit, Mich.
Midvale Mining & Mfg. Co., St. Louis, Mo.
Miller & Co., Chicago, Ill.
C .H. Milles Foundry Co., Chicago, Ill.
Milwaukee Chaplet & Mfg. Co., Milwaukee, Wis.
Milwaukee Foundry Equipment Co., Milwaukee, Wis.
Minneapolis-Moline Power Implement Co., Minneapolis, Minn.
Modern Equipment Co., Port Washington, Wis.
Montague Castings Co., Muskegon, Mich.
Motor Castings Co., West Allis, Wis.
Motor & Machinery Castings Co., Detroit, Mich.
Muskegon Piston Ring Co., Sparta Div., Sparta, Mich.
Nash-Kelvinator Corp., Nash Motors Div., Kenosha, Wis.
National Engineering Co., Chicago, Ill.
National Foundry Sand Co., Detroit, Mich.
National Malleable & Steel Castings Co., Cleveland, Ohio
National Metal Abrasive Co., Cleveland, Ohio
Neenah Foundry Co., Neenah, Wis.
New Jersey Silica Sand Co., Millville, N. J.
Nichol-Straight Foundry Co., Chicago, Ill.
Nordberg Mfg. Co., Milwaukee, Wis.
The S. Obermayer Co., Chicago, Ill.
Ohio Ferro-Alloys Corp., Canton, Ohio
The Ohio Foundry Co., Cleveland, Ohio
The Osborn Mfg. Co., Cleveland, Ohio
Packard Motor Car Co., Detroit, Mich.
Pangborn Corp., Hagerstown, Md.
The Parker Street Castings Co., Cleveland, Ohio
Peerless Mineral Products Co., Conneaut, Ohio
Peerless Pattern Works, Detroit, Mich.
George F. Pettinos, Inc., Philadelphia, Pa.
Phoenix Iron Works, Oakland, Calif.
The Plainville Casting Co., Plainville, Conn.
Pohlman Foundry Co., Buffalo, N. Y.
Pontiac Motor Div., Pontiac, Mich.
Production Pattern Co., Milwaukee, Wis.
The Pyle National Co., Chicago, Ill.
J. F. Quest Foundry Co., Minneapolis, Minn.
Riley Stoker Corporation, Detroit, Mich.
Rincon Foundry Co., San Francisco, Calif.
Robins Conveying Belt Co., Passaic, N. J.
Roots-Connersville Blower Corp., Connersville, Ind.
Sacks-Barlow Foundries, Inc., Newark, N. J.
Saginaw Malleable Iron Div., Saginaw, Mich.
St. Paul Foundry Co., St. Paul, Minn.
Sandusky Foundry & Machine Co., Sandusky, Ohio
Claude B. Schneible Co., Chicago, Ill.
Schwarb Foundry Co., Detroit, Mich.
Sealed Power Corp., Muskegon, Mich.
Semi-Steel Casting Co., St. Louis, Mo.
Sibley Machine & Foundry Corp., South Bend, Ind.
A. P. Smith Mfg. Co., East Orange, N. J.
Snow & Galgiani, San Francisco, Calif.
Sowers Mfg. Co., Buffalo, N. Y.
Spencer Turbine Co., Hartford, Conn.
Standard Automotive Parts Co., Muskegon, Mich.
Standard Foundry Co., Worcester, Mass.
The Standard Stoker Co., Inc., Erie, Pa.
The Sterling Foundry Co., Wellington, Ohio
Frederic B. Stevens, Inc., Detroit, Mich.
Stockham Pipe Fittings Co., Birmingham, Ala.
Stuart Foundry Co., Detroit, Mich.
Superior Foundry Co., Cleveland, Ohio
The Taylor & Boggis Foundry Div., Cleveland, Ohio
Taylor & Fenn Co., Hartford, Conn.
Textile Machine Works, Reading, Pa. (Fdry. Div.)
Thomas Foundries, Inc., Birmingham, Ala.
Warner R. Thompson Co., Detroit, Mich.
Tower Grove Foundry Div., Laclede Stoker Co., St. Louis, Mo.
Union Foundry Co., Fitchburg, Mass.
United States Graphite Co., Saginaw, Mich.
United States Pipe and Foundry Co., Burlington, N. J.
United States Radiator Corp., Detroit, Mich.
Universal Foundry Co., Oshkosh, Wis.
University of Minnesota, Student Chapter, A.F.A., Minneapolis, Minn.
Urick Foundry Co., Erie, Pa.
Utica Steam Engine & Boiler Works, Utica, N. Y.
Vanadium Corp. of America, New York, N. Y.
A. T. Wagner Co., Detroit, Mich.
Walker Machine & Foundry Corp., Roanoke, Va.
Walker Metal Products, Ltd., Windsor, Ont., Canada
Walsh Refractories Corp., St. Louis, Mo.
M. W. Warren Coke Co., St. Louis, Mo.
Warren Foundry & Pipe Corp., Phillipsburg, N. J.
Warren Pipe Co. of Mass., Inc., Everett, Mass.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Western Foundry Co., Chicago, Ill.
Western Materials Co., Chicago, Ill.
Whiting Corp., Harvey, Ill.
Wilcox, Crittenden & Co., Inc., Middletown, Conn.
The A. C. Williams Co., Ravenna, Ohio
Wilson Foundry & Machine Co., Pontiac, Mich.
Wisconsin Grey Iron Foundry Co., Milwaukee, Wis.
Wisconsin Steel Company, Chicago, Ill.
Wolverine Foundry Supply Co., Detroit, Mich.
E. J. Woodison Co., Detroit, Mich.
Woodruff & Edwards, Elgin, Ill.
Woodward Iron Co., Woodward, Ala.
Worcester Foundry Co., Worcester, Mass.
Washburn Shops of Worcester Polytechnic Institute, Worcester, Mass.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yale & Towne Mfg. Co., Stamford, Conn.
Youngstown Foundry & Machine Co., Youngstown, Ohio

**Individuals**

The following men organized committees in a number of A.F.A. chapters to raise funds for the Project:

Wisconsin Chapter—J. F. Oesterle, University of Wisconsin, Madison, *Chairman;*

St. Louis District Chapter—C. B. Shanley, Semi-Steel Casting Co., *Chairman,* and Webb Kammerer, Midvale Mining and Mfg. Co., St. Louis;

New England States—Henry S. Washburn, Plainville Casting Co., Plainville, Conn., *Chairman;*

Detroit Chapter—E. C. Hoenicke, Eaton Mfg. Co., Fdry. Div., Detroit, *Chairman;*

Northeastern Ohio Chapter—J. H. Tressler, Hickman Williams & Co., Cleveland, *Chairman;*

Michiana Chapter—W. A. Bachman, New York Central R. R. Co., Elkhart, Ind., *Chairman;*

Western New York Chapter—R. D. Loesch, Lake Eire Foundry Co., Buffalo, *Chairman;*

Northern California Chapter—S. D. Russell, Phoenix Iron Works, Oakland, Calif., *Chairman;*

Chicago Chapter—J. J. Fox, Wisconsin Steel Co., Chicago, *Chairman;*

Central New York Chapter—F. F. Shortsleeve, Elmira, N. Y., *Chairman;*

Twin City Chapter—Fulton Holtby, University of Minnesota, Minneapolis, *Chairman;*

Western Michigan Chapter—R. F. Flora, The Clover Foundry Co., Muskegon, Mich., *Chairman;*

Quad City Chapter—A. D. Matheson, French & Hecht, Davenport, Iowa, *Chairman;*

Metropolitan Chapter—Henry C. Seidel, Penn-Rilton Co., New York, *Chairman;*

Birmingham Chapter—Henry J. Noble, American Cast Iron Pipe Co., Birmingham, Ala., *Chairman.*

# A.F.A. PRESIDENT'S

## ANNUAL ADDRESS

**Fred J. Walls**
**President**
**A.F.A.**

This, our "Golden Jubilee Convention" and our seventh convention in the great city of Cleveland, is more than a celebration of the fiftieth anniversary of the founding of the American Foundrymen's Association. It marks a half-century of accelerated progress in the castings industry unmatched in all the previous 50 centuries or more of its history. This is the golden jubilee of a renaissance, the anniversary of a transition from rule-of-thumb to an industry built upon solid scientific foundations, upon chemistry, upon physics, upon metallurgy, upon mechanical engineering, and upon techniques which modern research is developing daily.

It would not be possible, nor would it appear necessary, to attempt to recount each of the great advances the foundry and its allied industries have made over the past 50 years. They are certainly vivid in the memory of the many here who have served 50 years in the foundry industry; and the youngest among us can appreciate how great has been this transition that brought founding from a mysterious art, fortified by little more than melters' and molders' secrets, to a scientific plane on which it is equal to the most exacting requirements of production for war or for peace.

As members of A.F.A. we are naturally, and justly, proud of the progress in the industry we serve. And we are proud, too, of the fact that the half-century of our industry's greatest advances parallels in time the first 50 years of our Association. This is not to claim, however, that A.F.A. deserves the credit.

All credit for the great progress of the industry belongs to the men of the foundry industry and to the men allied with it, eager for its constant improvement, and to the ever-growing number of tireless workers within and without the industry who have been unceasing in their researches to its advantage. But proud, indeed, we may be of this: These men are A.F.A.

### 1896 Resolution

In that month of June of 1896 when 345 foundrymen gathered in Philadelphia and organized the A.F.A., they resolved that "it is desirable that the interests of the foundry business be furthered by a closer association among all the foundrymen of America in order that any improvements or valuable information concerning the business, or any portion of it, should become as widely available as possible."

A year later at the Association's second annual convention, held in Detroit, its first president, the late Francis Schuman, said, "We are here to formulate ways and means toward the advancement of our industry, both as a mechanic art and a source of benefit to those engaged in its practice."

Mr. Schuman further stated, "The continued growth in exceptional size, quality and form of foundry products to meet the special purposes intended by the engineer, compel the application of a knowledge of the science far beyond any that our predecessors ever thought of; and not only does this apply to the leader, whether superintendent or foreman, but equally to the handicraftsman in all branches of our business." Mr. Schuman's statement 49 years ago is perhaps more imperative today than it was then.

A more formal expression of the objectives of the A.F.A., as outlined in its articles of incorporation, is, "to promote the arts and sciences applicable to metal casting manufacture and to improve the methods of production and the quality of castings, to the end that the increasing utility of all classes of castings may result advantageously to all persons engaged in the foundry and related industries and to all users of foundry products."

In its 50 years of service to the castings industry, A.F.A. has never lost sight of the objects for which it was organized. It has grown tremendously and parallels the progress made in the great industry it serves.

Its most important work continues to be the maintenance of media for the free interchange of technical information, the encouragement of research and unrestricted discussions of new developments, the cultivation of skills and the dissemination of knowledge among those practicing the scientific art of founding. In short, its purpose is the promotion of the science of founding.

The Transactions, chronological records of foundry progress and

---

**Address of A.F.A. President Fred J. Walls, International Nickel Co., Detroit, presented at the Annual Business Meeting at the Fiftieth Annual Meeting of A.F.A., at Cleveland, May 9, 1946.**

practice over 50 years, whose pages total over 31,000, is evidence of how well your Association has served as a clearing house of information. And I dare say, without boasting, that there is not a single major development in foundry practice they do not record.

Out of the effort of A.F.A. to disseminate information of practical lasting value to the industry, and for those who will enter it, has grown a foundry technical library of some 5,000 pages. The most recent addition is a 500-page publication of the Cupola Research Project —THE CUPOLA OPERATIONS HANDBOOK.

This book is the work of over 125 outstanding gray iron metallurgists and practical foundrymen. It is the most complete and modern reference ever published on this most used type of melting furnace. Supplementing this library are numerous other publications, symposia, committee reports, and special studies with which you are familiar.

### American Foundryman

I should like to say a few words about our monthly technical magazine, AMERICAN FOUNDRYMAN; and in this reference I am certain we are justified in unlimited boasting. I am proud of AMERICAN FOUNDRYMAN in its new dress, proud of its wide acceptance internationally as well as nationally, proud of the reader interest it commands, proud of the staff who made it what it is and of their future plans; and I cannot help but think that everyone of you are proud of it, too.

The working committees of A.F.A. are the foundation heads of the vast stream of technical and practical information which continues to be channeled with increasing volume to our membership, to schools, to other societies and to all who are interested in the production and use of castings. On these committees over 500 individuals are giving willingly and freely of their time, their skill and their experiences in appreciation of the fact that there is no real progress unless all progress.

We salute these men and sincerely thank them for their invaluable contributions to the great progress of the castings industry and to the assurance they give that even greater strides will be made in the years to come through their collective efforts.

The willingness of men to serve on A.F.A. committees is notable and significant. As early as 1910 Arthur T. Waterfall, then president, commented at the Association's fifteenth annual convention, "Those of you present, who can look back to the earlier years remember the difficulties encountered in getting men with courage to tell of their experiences and their successes in producing a better class of work at less cost, will note today the eagerness of foundrymen to give this information to their chosen industry. No longer do they surround the foundry industry with the air of mystery that formerly enveloped it, realizing now that in the interchange of ideas we are mutually helpful."

Truly, we are celebrating here today the Golden Jubilee of a renaissance, for this philosophy is truer today than it was then.

From the first days of its organization, the Association has cooperated in the problem of training men from the elementary stages of apprenticeship through to compiling and disseminating information constantly sought by students and teachers alike. By providing apprentice awards, it has recognized and given impulse to the importance of training young men in the art and science of founding.

The Cost Committee, one of our oldest committees, has constantly emphasized the importance of sound cost determination and given impetus to the excellent cost systems developed by various foundry trade associations.

### 8300 Members

Membership growth of A.F.A. has been nearly a straight line since the formation in 1934 of the first of our 33 Chapters. Today, our membership is near 8,300 (to be more exact, 8,285), which is a record high. That the interest in A.F.A. extends throughout the world is attested by the number of foreign members and guests attending this convention.

The leadership which your Association assumed in establishing an exchange of technical information with foundry associations in other countries is renewed and expanded at this convention. Attending this convention are representatives of 19 foreign countries and the presence of these visitors from abroad, many of them A.F.A. members, emphasizes the international aspect of foundry cooperation that forms the basis for your Association's progress.

On Monday, this convention received a paper from the Foundrymen's Association of Czechoslovakia. Today and tomorrow, exchanges from France and England will be presented. The first of a new series of exchange papers, that of the Institute of Australian Foundrymen, will also be presented.

We are happy to cooperate with our friends "down under" and extend to their membership our sincere good wishes. Among my hopes is one for the continuation of our International Foundry Congress. Later today an Organizational Committee is meeting to consider future plans.

### Exhibit Space

Everyone here has viewed, and will see again, the interesting and instructive exhibits of foundry equipment, materials and services which fill the six halls covering eight acres of this Auditorium. To the 280 exhibitors at this Golden Jubilee Foundry Show, we express our appreciation and we sincerely hope that their efforts have been worth while.

To the members of the Northeastern Ohio Chapter, our host chapter, we express our sincere thanks for all that you have done in helping us make this event the success it has proved to be.

The technical program, comprising nearly 150 papers and addresses, panels and round table discussions, assumes gigantic proportions when compared with the technical program of our first meeting at which less than half a dozen were presented.

For 50 years it has been the privilege of the presidents of your Association (43 of them) to summarize for the membership the activities of the fiscal year. So many things have happened since last July that I am sure I would be abusing this traditional privilege were I to attempt to mention all of them.

I assure you, however, that your Executive Committee and your Board of Directors have carried out faithfully, ably, and without hesitation, all the responsibilities you have entrusted to them. And each of their

actions was guided by one question alone: What will be for the best interests of the foundry industry and the American Foundrymen's Association?

No Executive Committee or Board of Directors ever hopes, of course, to satisfy completely the unstudied desires of more than 8,000 individuals. We have appreciated most of the criticism received because it has been constructive and will be helpful in future decisions of new boards.

Unpredictable circumstances made it necessary to call several special meetings of the Executive Committee in addition to the regular meetings held every 2 months. As president, I should like to acknowledge my sincere appreciation for their time, their patience and their sound advice.

During the fiscal year, we saw the cessation of hostilities, the end of World War II, and with it the turmoil of reconversion. The uncertainties imposed upon the castings industry by these events have been reflected in the work of the Association and have added tremendously to the burdens of our staff.

This, coupled with the growth in membership and our constant desire to increase our service, necessitated several additions to the headquarters' staff in Chicago. To these new men and women, and to Ed Hoyt and Bob Kennedy, and to our Secretary, Bill Maloney, praise and credit for the success of this convention are accorded. We are proud of the job they have accomplished under very difficult conditions.

### Technical Director Hindle

Early this year, Norm Hindle was taken seriously ill and, while he is coming along nicely, his doctor would not permit him to attend this convention. I know that Norm misses being here as much as all of us miss having him here to participate in the fruits of his untiring efforts.

On March 15th of this year, Miss Jane Reininga, the Association's assistant treasurer, retired after active service of 30 years as a staff member. She joined the staff at the time Ed Hoyt was first elected secretary and served successively as stenographer, bookkeeper, office manager, and was appointed assistant treasurer in 1941. We miss her in the many positions in which she had so faithfully and tirelessly served, and we wish her every measure of happiness and the best of health in her retirement.

To meet the challenges from within and without the foundry industry, your Directors authorized the Secretary to proceed with enlarged educational, research, publication and publicity programs, most of which are well under way. The details of these plans will be further outlined at the forthcoming Annual Chapter Chairmen's Conference to be held on July 24-25, prior to the Annual Board Meeting.

### A.F.A. Financially Strong

I am more than pleased, and exceedingly proud, to be able to report that, through your cooperative effort, the Association is stronger financially than ever before. Its financial statements reflect not only greater activity and good management in your interest, but also a greater appreciation among foundrymen and the men of allied fields of the dollars-and-cents value of cooperative effort along technical and educational lines, plus a strengthened confidence that by working together we progress and by keeping together we achieve the success we are seeking.

The 1945-46 budget of the American Foundrymen's Association, with a provision for surplus, totals above one-third of a million dollars. Reflecting steady growth, greater service, wider participation, it is the largest budget in the Association's history. More than that, it is conservative. Giving greater service, we are living well within our income; and we are financially able, with our service value-tested, to put forward a greater cooperative effort.

In the 1945-46 budget, income from membership dues for the fiscal year ended June 30th was estimated at $135,000.00. In the first 10 months of the fiscal year dues have actually totaled $148,444.85. Anticipated advertising revenue from AMERICAN FOUNDRYMAN for the fiscal year was placed at $75,000.00. As of May 1st sales of advertising totaled $82,440.76.

Receipts from sales of exhibit space and from exhibit permits is also greater than anticipated. In short, income from all sources in the first 10 months of this fiscal year has been about 16 per cent greater than the total anticipated for the full year.

I have pointed out that we are living well within our budget. As a matter of fact, estimated total cost of operation for 1945-46 has proven, by the experience of 9 months of actuality, to be as high as estimated income has proven to be conservative. As of March 31st, we were within the budget for the full year by better than $158,000.00.

You will be interested in learning that the 1945-46 budget underestimated the item of chapter refunds. For the first 9 months of the 1945-46 fiscal year refunds to chapters have amounted to $25,333.76, an average of more than $2,800 a month, against an estimated average of $2,250 a month. This reflects increased membership, in addition to the increase in chapter refund rates as provided in the new dues structure which went into effect last July.

I regret, exceedingly, that I was unable to visit all the chapters during my term as president. My intentions, I assure you, were excellent, but travel conditions and Association headquarters' demands prevented. You will pardon me if I say that these same excuses apply also to Secretary Bill Maloney.

However, we managed to visit most of the chapters, and those visits were valuable to us in that they afforded an opportunity to discuss with the chapter board members our mutual problems and to take back to the National Board many excellent suggestions of benefit to all the membership.

### Regional Conferences Helpful

It was my good fortune, also, to be able to attend four Regional Conferences. They impressed me greatly as educational media and as effective means for widening an appreciation of the foundry industry and its best practices.

I have given you a very sketchy report, but I have purposely hurried in order that I might impose upon your indulgence to give you some dreams as to the future of the American Foundrymen's Association and the great industry it serves. As we pass this fiftieth birthday marker, we

can only imagine the magnitude of the one hundredth marker.

We must borrow some time from our present problems and utilize it for the placing of more permanent beacons if we are to guide our ship through the unknown currents we are running into and thus avoid drifting in the wrong direction. Under our charter as a technical society we cannot enter into the construction of, nor the placing of, the most important lighthouses that mark the channel to future progress and prosperity in the castings industry.

If we assume that the now dim lights in these beacons will brighten in due course, and we must have faith that they will, then we have only to locate and build one important lighthouse, science and its application.

It is wonderful for an Association to be an integral part of an industry so old that we cannot trace its beginning and yet so young in its scientific deevlopments that we cannot comprehend its future. The mysteries of its birth may be hidden deep in the earth's rocks, but its future progress lies in the individual and cooperative efforts of those associated with it.

The future of the foundry industry and that of this Association is what we make it, and that is dependent upon our concept of what it should be.

I can visualize the A.F.A. membership tripled and with at least 50 chapters. It will not take a half-century to accomplish this, for it can be done in a decade, and I suggest that we pilot our ship toward that beacon. The organization dates of five chapters fall within the year 1945 (Oregon, Saginaw Valley, Northwestern Pennsylvania, Mexico City and Central Illinois).

Obviously, there is room for chapter growth. Ohio, for example, has 522 foundries (as listed by Penton) and five chapters, or a chapter for approximately every 100 foundries in the state, if we disregard some overlapping. If this is an ideal situation, and it seems to be in keeping with the benefits derived from chapter activities, then we should have 50 chapters in the United States alone.

If we add to these the requests we have had recently from other countries, our goal should be even higher. To me, this is a definite indication of the desire for free exchange of ideas, as mentioned earlier.

What about the future foundry, its equipment, its personnel, and its processes? The great developments, stimulated by the requirements of war, already are projected into peace-time production. It seems only logical that, as challenges from developments in other industries appear, they will stimulate developments in the science of casting.

Although they might now seem fantastic, gasless cores and molds, waterless binders, fireless melting units, castings that require no cleaning and with dimensional tolerances close to machining tolerances, all appear possible.

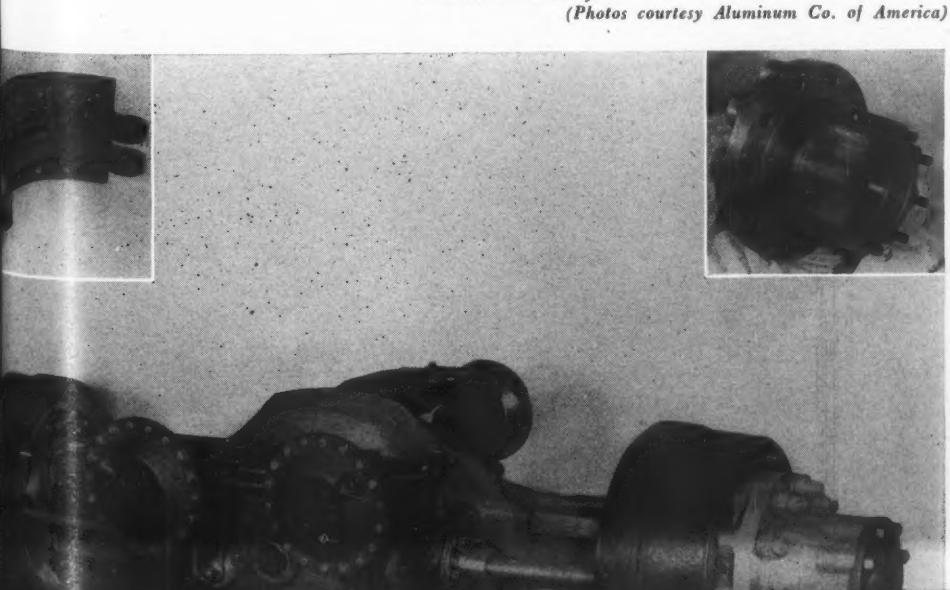
Mechanical equipment in industry to eliminate drudgery will parallel similar developments in the future home. Working conditions in all industries will parallel changing living standards. We all like pleasant dreams and dread horrid ones. Before I expose my dreams to possible ridicule by future generations, I must return to the present.

Let us have confidence in our ability to overcome all challenges and content our minds with the fact that throughout the history of the world the casting process has always survived and progressed with every advance in science, culture, or even revolutions. We must put on a bigger front and have the courage of our own convictions.

In closing, I wish I were capable of expressing to you how grateful I am for the privilege you have accorded me, that of serving you as president of the American Foundrymen's Association during its Golden Anniversary Year. I consider the Presidency of the A.F.A. the highest honor a foundryman can hope for and the highest honor he can receive. I am certain that every one of the 43 men who have preceded me in this high office were as deeply grateful as I am for the opportunity to serve a great Association.

*Timken S-200-P heavy-duty aluminum truck rear axle, with sand cast housing, brake shoes (inset, left, brake shoe assembly), and hubs (inset, right, aluminum hub).*

*(Photos courtesy Aluminum Co. of America)*



## Light Castings in New Transport Application

ALUMINUM SAND CASTINGS comprise the first light-weight, heavy-duty aluminum truck axle offered by an axle builder as standard equipment, the "S-200-P", developed by Timken-Detroit Axle Co., Detroit, whose engineers worked closely with those of Aluminum Co. of America on design of the unit now in production after more than a year of severe road and laboratory tests.

With housing, hubs and brake shoes of aluminum, and weighing 220 lb. less than when constructed with malleable iron components, the axle is available with either of two types of final drive — interchangeable in same housing, and using same shaft.

The light metal castings are reported as expected to compensate for higher initial cost through increased pay load as a result of reduction in dead weight, with service life equal to that of conventional axles. Castings are supplied by Aluminum Co. of America to the Timken company, which machines them to dimensions.

# OTTAWA MEETING
## *Aids Regional Foundry Technology*

TECHNICAL DISCUSSIONS of latest foundry techniques and methods were brought within reach of foundrymen in the Ottawa area April 5-6, when Eastern Canada and Newfoundland A.F.A. chapter staged a highly successful regional conference, and Chapter Chairman G. E. Tait, Dominion Engineering Works, Limited, Lachine, Que., officially welcomed two hundred foundrymen (a group of whom are seen in the accompanying cut) from Ontario, Quebec, and United States to headquarters at the Chateau Laurier Hotel, Ottawa.

Following registration Friday morning, April 5, delegates heard C. S. Gibson, Ontario Mining Association, discuss "Prevention of Silicosis." The speaker described the disease and steps taken for its control in Ontario mines.

### Discussion Highlights

Leading off the technical sessions of the afternoon, K. A. DeLonge, International Nickel Co., New York, presented an instructive discussion of proper methods of introducing molten metal into molds in manufacture of castings. Emphasis was placed on understanding and application of fundamental laws of physics.

Following speaker, Joseph Nixon, Whitehead Metal Products Co. Inc. of New York, Buffalo, N. Y., described latest developments in quality and cost control for the foundry.

General discussion of the above subjects and many others of interest to foundrymen followed the remarks of the foregoing speakers. Discussion leaders were: W. L. Bond, Ottawa Car & Aircraft, Ltd., Ottawa; E. N. Delahunt, Warden King, Ltd., Montreal, Que.; R. Gibson, R. J. Ferguson & Sons, Ottawa; and W. T. Shute, Canadian Car & Foundry Co. Ltd., Montreal, Quebec.

A.F.A. National Director Joseph Sully, Sully Brass Foundry, Ltd., Toronto, addressed the delegates briefly Friday evening. Mr. Sully described A.F.A. activities, extended a special invitation to the Golden Jubilee Congress in Cleveland and discussed methods of interesting youth in foundry careers.

Attention of the delegates Saturday was turned to plant visitations, with tours arranged through local foundries in Ottawa and its vicinity, and to the Bureau of Mines Research Laboratories. At the latter, where a large group made a thorough inspection of extensively equipped facilities, special interest was shown in the experimental foundry. Sand molding and centrifugal, die, and precision casting equipment were accessible to the visitors; who also saw instruments for physical testing, microscopic and x-ray examination.

Arrangements for the foundry gathering, which served to focus current interest in industrial possibilities of Ottawa district, were in the hands of a committee headed by Chapter Director C. V. Hacker, Lynn MacLeod Engineering Co. Ltd., Hull, Que., as *Chairman,* and Chapter Director J. H. Newman, Chamberlain Engineering Co. Ltd., Montreal, as *Vice-Chairman.* Also included on the committee were: N. C. MacPhee, Bureau of Mines, Ottawa; I. C. Shepherd, Beach Foundry, Ltd., Ottawa; Chapter Director A. E. Cartright, Robert Mitchell Co. Ltd., St. Laurent, Que.; E. G. Jennings, Dominion Engineering Works, Ltd.; and A. E. Weedmark, Findlays, Ltd., Carleton Place, Ont.

*Foundry products are inspected by experts, as delegates to the Ottawa Regional Foundry Conference visit metallurgical research laboratories of the Bureau of Mines, Saturday, April 6.*

# MALLEABLE FOUNDRY COREMAKING PRACTICE

**Core sand in a mechanized malleable foundry making pipe fittings and small castings must primarily meet the requirements of the core shop in making cores which, after performing their functions in the molds, become the basis for a satisfactory molding sand.**

**D. F. Sawtelle**
**Metallurgist**
**Malleable Iron Fittings Co.**
**Branford, Conn.**

It is customary in many malleable foundries making castings varying in size from several pieces to the ounce to several lb. each to use two or three grades of core sands, which vary in A.F.A. fineness from 25 to 162.

When the author presented a paper in 1942* three such widely varying sands were being used in the core shop. They were listed in that paper under Table 1 as, Wareham, Providence, and Jersey No. 52, with A. F. A. Grain Fineness Nos. 72, 160, and 23, respectively.

These sands had been used successfully for several years prior to mechanization, and was thought best to continue their use during the first few months of mechanized operation. At that time, a little more than half the cores were being made in core blowing machines and the remainder by hand.

Coarse Jersey No. 52 sand was considered essential by the core shop, was used in several core mixers to give the cores greater permeability, collapsibility, and help in blowing the cores. It was regarded as detrimental to the system molding sand and was soon replaced by a sand of A.F.A. Grain Fineness No. 35.

Fineness No. 35 sand was not considered as detrimental to the molding sand and, by slight changes in the proportions with which it was mixed with the Wareham and Providence sands, it gave good results in the core shop and in the molds.

The next change in the core sands was the substitution of a so-called "Marion" sand of Grain Fineness No. 119 for both the Providence and Wareham sands. The final change was the substitution of a sand of Fineness No. 48 for the No. 35 sand.

### Screen Tests

Table 1 shows the screen tests of the three core sands in use when the mechanized foundry as started on June 23, 1941, and the two sands which are being used at the present time.

Use of the Marion sand and the Jersey No. 45 sand in the core shop has decreased the percentage of coarse grains in the system molding sand. The total percentage on screens 6-12-20-30 has dropped from 7.45 to only 2.03 per cent.

*Type of Binders.* The malleable core shop uses linseed as an oil binder in combination with a cereal binder known as dextrine sweepings. In past years many types of core oils and dry binders have been tried with varying degrees of success, but under the conditions existing in this core shop and foundry, it is believed that the best results are obtained when using linseed oil and dextrine sweepings.

*Other Materials Used.* A fine grade of sawdust is added to some core mixtures solely to attain high collapsibility. This is necessary only in cores for some of the largest fittings and as most of these are made on side floors, the sawdust does not enter the system molding sand.

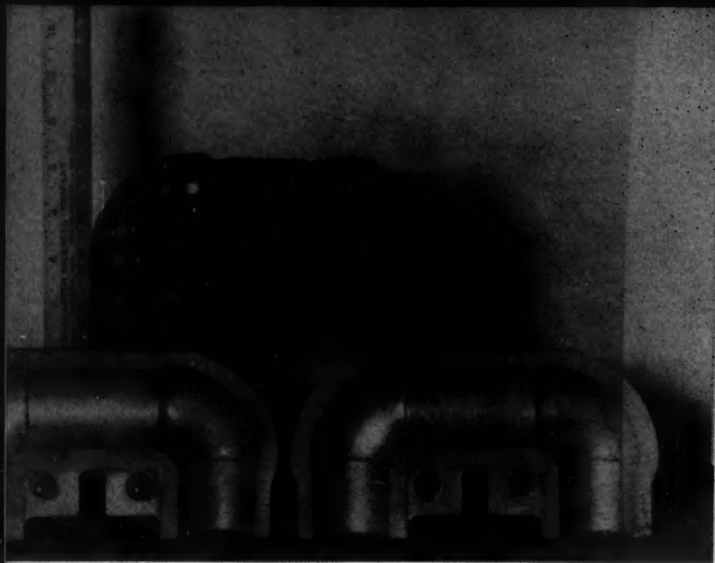
Kerosene is also used in amounts of 0.1 to 0.2 per cent by weight. This does not appear in the core mixtures which follow. Its purpose is to prevent the core sand sticking to the core boxes, to some extent, and to retard the air hardening of a mixed

**Table 1**
Screen Analysis of Core Sands

| *Screen No.* | Remaining on Screen, per cent: *Jersey No. 52* | *Wareham* | *Providence* | *Marion* | *Jersey No. 45* |
|---|---|---|---|---|---|
| 6-12-20 | 8.16 | 1.02 | — | 0.09 | 0.20 |
| 30 | 35.56 | 0.98 | 0.04 | 0.34 | 2.00 |
| 40 | 47.24 | 2.28 | 0.07 | 0.93 | 12.10 |
| 50 | 6.68 | 6.72 | 0.38 | 2.85 | 31.50 |
| 70 | 0.66 | 21.08 | 2.30 | 12.60 | 36.80 |
| 100 | 0.46 | 29.12 | 12.09 | 24.72 | 15.20 |
| 140 | 0.22 | 23.84 | 24.80 | 30.16 | 1.90 |
| 200 | — | 10.04 | 25.05 | 16.44 | 0.30 |
| 270 | — | 2.88 | 13.21 | 5.28 | — |
| Pan | — | 2.00 | 22.06 | 6.59 | — |
| A.F.A. Grain Fineness No. | 23 | 72 | 162 | 119 | 48 |

This paper was presented at a Malleable Foundry Practice Session of the Fiftieth Annual Meeting, American Foundrymen's Association, at Cleveland, May 7, 1946.

*D. F. Sawtelle, "A Sand Control Program in a Mechanized Malleable Foundry," Transactions, American Foundrymen's Association, vol. 50, pp. 830-844 (1942).



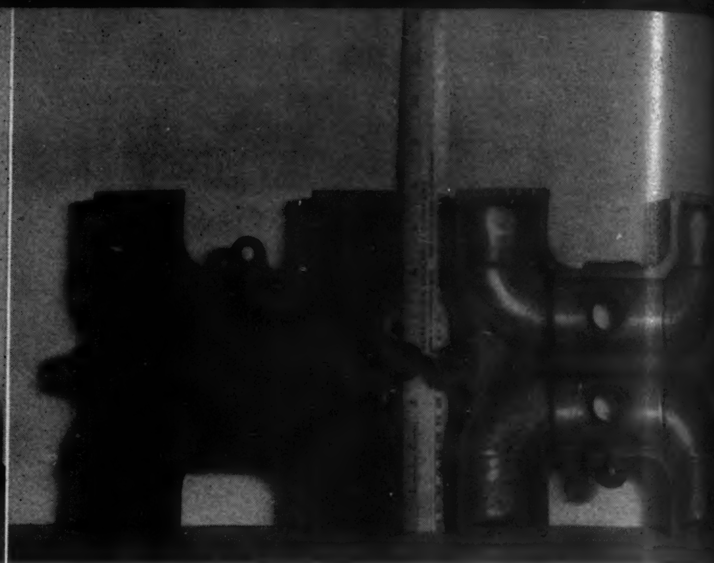


*Fig. 1 (left)—Two halves of a core box and a dryer into which core is transferred for baking. Fig. 2 (right)—Multiple system in which the core dryer (left) constitutes one-half of core box and "mother" (right) the other half.*

**Table 2**

Mixture for Small Cores

| | Cores | |
|---|---|---|
| *Material* | *Hand-made* | *Blown* |
| Marion sand, bu. .. | 6 | 5 |
| Jersey sand, bu. .... | — | 1 |
| Linseed oil, qt. ...... | 2½ | 4 |
| Dextrine, qt. .......... | 2 | 7 |
| Water (approx.), per cent .............. | 4-5 (by wt.) | 2 (by wt.) |

batch of core sand before being used.

Kerosene also assists if the moisture in the mixed sands is on the high side. Sometimes this is the case, for while the Jersey No. 45 sand is purchased dry, the Marion sand is not. Water content will be discussed in more detail under core mixes.

*Core Mixtures and Consumption of Materials.* Six different mixtures in daily use are listed in Tables 2, 3, and 4. Several trends in these core mixtures are worthy of close attention. The sand mixtures for blown cores have less water, more oil, and much more dextrine than the corresponding mixtures for handmade cores. They also contain the coarse Jersey sand which is not used in handmade cores except as in

**Table 3**

Mixture for Medium Size Cores

| | Cores | |
|---|---|---|
| *Material* | *Hand-made* | *Blown* |
| Marion sand, bu. .. | 6 | 5 |
| Jersey sand, bu. .... | — | 1 |
| Linseed oil, qt. ...... | 1¼ | 3 |
| Dextrine, qt. .......... | 2 | 7 |
| Water (approx.), per cent .............. | 5-6 (by wt.) | 3 (by wt.) |

Table 4, for large collapsible cores. The addition of the coarser-grain sand is an important factor in the successful blowing of these cores.

It is felt that a great deal of the success in blowing cores is due to these mixtures, which has been achieved only after many changes and experiments. The percentage of cores made by this method has increased from 50 per cent in 1941 to 80 per cent at the present time.

The foregoing core mixes are tabulated just as they are used, with no attempt to convert them to percentage by weight. The amount of

**Table 4**

Mixture for Large Collapsible Cores

| | Cores | |
|---|---|---|
| *Material* | *Hand-made* | *Blown* |
| Marion sand, bu. .. | 3½ | 4 |
| Jersey sand, bu. .... | 1½ | 1½ |
| Sawdust, bu. .......... | 1 | ½ |
| Linseed oil, qt. ...... | 1 | 1½ |
| Dextrine, qt. .......... | 1 | 3 |
| Water (approx.), per cent .............. | 6-8 (by wt.) | 4 (by wt.) |

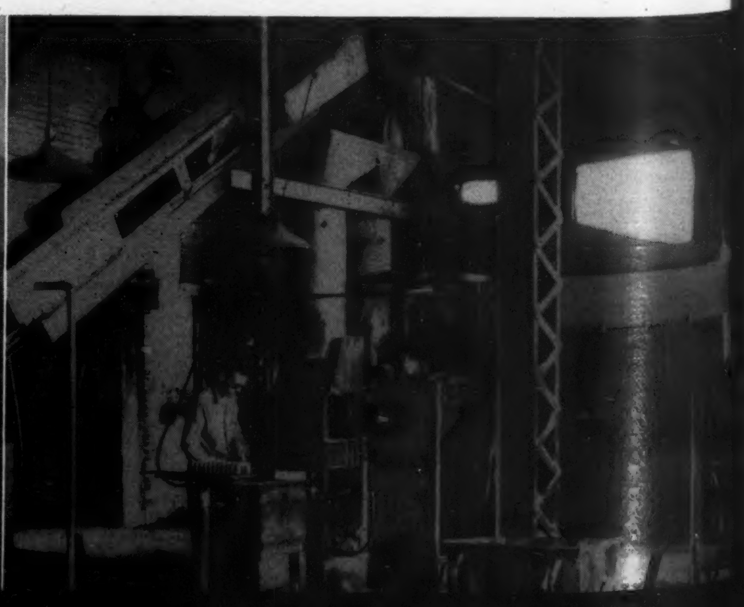


*Fig. 3 (left)—Blowing cores directly into dryers (multiple system). Dryers are placed on rack for transfer to baking ovens. Fig. 4 (right)—General view of core shop. Belt elevator (left) for sand hoppers supplying two blowing machines. Operator is making cores by unit system.*

*Fig. 5 (left)—Cores stacked on racks being transferred to stationary, batch type, oil-fired core ovens. Fig. 6 (right)—Outlet end of core oven with rack of cores suspended from overhead conveyor.*

materials used by weight and the quantity of cores to tons of metal poured are shown in Table 5.

From these figures, it is seen that one ton of cores is needed for every 9 tons of metal poured; that the ratio by weight of core binders to sand is one to 45; that the linseed oil amounts to 48 per cent, and the dextrine sweepings to 52 per cent of the binders used.

*Core Making Methods.* It is not the purpose of this paper, nor within the scope of the writer to attempt to give in detail the many methods and tricks of the trade used in making cores by hand. Intricate cores, many of the larger cores, and those which could be blown but only a small number required, usually are handmade. The core shop foreman selects the least expensive method available.

Several standard fitting cores are made both by hand and by blowing machines, with costs running equal, but these instances are rare. Where the number required is in the thousands per run, and sometimes a million or more per year, blowing is ideal and the cost is only half that of handmade cores.

In blowing cores, No. 2 machines at 125 lb. air pressure are used. It is important to have full air pressure. There are two methods or systems for blowing cores, different equipment being required for each.

One method is known as the unit system, and the other as multiple. In the unit system a split core box is used, both halves of which are actually machined to the dimensions of the cores to be made and equipped with the necessary air vents, air and sand inlets. The sand is blown into the box and then either transferred to a core dryer in which it is baked, or, in some instances, dried on a tray.

In all cases the cores must be removed from both halves of the core box, which is then ready for re-use. Figure 1 shows the two halves of a core box and a dryer into which the core is transferred for baking.

The core box is cast of low-carbon gray iron which offers better resistance to wear than softer high-carbon gray irons. The box is finished to dimensions in the pattern shop and the necessary air vents inserted. The correct size and placing of the vents, is learned only by experience.

Core dryers are cast of aluminum, or gray iron, a little oversize, sometimes perforated, and are used as cast. A complete set of equipment

**Table 5**

CONSUMPTION OF COREMAKING MATERIALS

Period Covering Pouring of 14,000 Tons of Metal

| *Material* | *Tons* |
|---|---|
| Sand | 1,600 |
| Linseed oil | 17 |
| Dextrine | 18.5 |
| Kerosene | 0.5 |
| Sawdust | 1 |

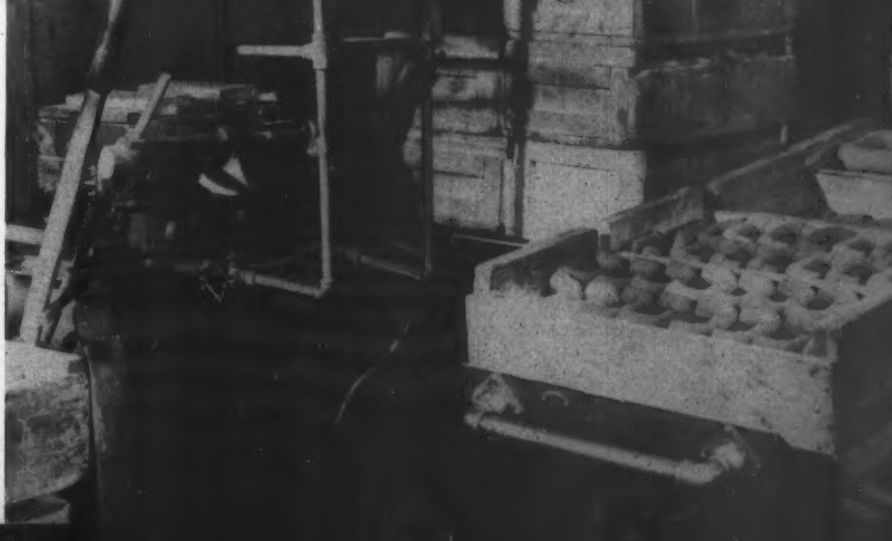


*Fig. 7—Boxes of cores loaded on truck for delivery to molding bench.*

consists of a carefully machined and vented split core box, and several hundred core dryers. This method and equipment is used when blowing fitting cores of over 2-in. diameter.

In the multiple system, the core dryers constitute one-half of the core box and are all accurately machined and pinned to fit the other half, which is known as the "mother." A set of equipment consists of one "mother" and several hundred dryers. As the sand is blown into the "mother" and one dryer, it is necessary only to remove the "mother," the core remaining in the dryer.

This system is much faster as the core does not have to be carefully transferred from the core box to the dryer. The cores are more accurate in dimensions. The necessary machining of the dryers, however, makes the original cost of the equipment much higher. Figure 2 shows the "mother" on the right and the dryer on the left.

Figure 3 shows the actual operation. To the right of the operator is a core blowing machine and to his left a rack on which the blown cores are transferred to the oven for baking. The operator shown is using the multiple system, blowing the cores directly into the dryers.

### Core Shop

Figure 4 shows a more general view of the core shop. To the left is the belt elevator for filling the overhead sand hoppers of two blowing machines. In the center is an operator making cores by the unit system. However, the core has not been transferred from the core box to a dryer but is standing on a plate for drying.

*Core Baking.* The cores, stacked on racks as shown in Figure 3, are then transferred by a hand-jack truck to stationary, batch type, oil-fired core ovens, as shown in Fig. 5. These ovens are heated by oil burners located on the floor below, the heat entering from flues in the center of the oven floor and between the two racks of cores. The exhaust gas flues are located on the inside walls of the ovens about 1½ ft. above the floor level.

All cores over 1-in. thick are baked in these ovens. The time cycle varies from 2 hrs. at 450 to 475° F. for a batch of the smaller cores to as long as 12 hrs. or overnight for the heavier cores. The temperature on the overnight bake is reduced to 325 to 350° F.

The core shop foreman for several reasons prefers the long bake at a low temperature to a quick bake at temperatures of 475 to 500° F., even though linseed oil is capable of producing a good core under a wider variation of temperatures than many of the compounded core oils.

### Baking Cores

By weight, the stationary ovens bake a little over half of the cores that are made. All of the smaller cores are baked in a continuous type, oil-fired oven, designed and installed in the author's plant over 30 years ago. It has been in almost continuous operation since that time, the only major change being the installation of oil burners to replace the original coke fires.

Figure 6 shows the outlet end of this oven. A rack of cores suspended from an overhead monorail conveyor can be seen. To the extreme left is a rack from which the baked cores have been removed. They have been placed on the single conveyor located at the extreme right side of the picture, where they proceed to the inspection, counting, and packing in boxes for transferal to the molders' work bench.

Between the empty and full trays can be seen the shaft with a sprocket wheel on the top, which carries the drive chain — moving the trays through the oven and back to the starting point in a continuous loop. The electric motor driving mechanism is on the opposite end.

The trays proceed through the oven at the rate of 1 ft. per min.

The baking portion of the oven, through which they travel, is 45 ft. long; therefore they are in the baking zone at 450 to 475° F. for 45 min. In the next 15 ft. most of the smoke and gases are exhausted. In the last 25 ft., the cores are cooled to handling temperature by air drawn from outside the building and blown across the slowly moving trays of cores.

*Core Transportation.* The present core shop building was centrally located between two foundry buildings which at one time contained a total of four batch type air furnaces and two cupolas. The present mechanized foundry was built in the farther end of the more modern of these two buildings. This necessitates the transportation of the cores from the core shop to the molders' benches in the foundry, a distance of several hundred feet.

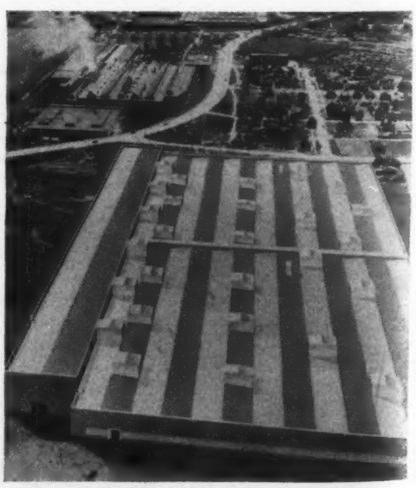
Figure 7 shows the two-wheel, rubber-tired, spring-suspended type of truck, delivering a load of cores to the molders' bench. The raised ends on each box, in which the cores are packed, prevent crushing. Each molders' station has room for five or six boxes of cores. Delivery of cores to the molders and the return of the empty boxes continues during the entire working day.

Since the mechanized foundry occupies only a little over half of the building, plans are being considered for the construction of a new core shop in the foundry. The new shop, with the many improvements which are planned, may well be the subject of another paper on core shop practice.

## Battelle Wins Award

CITING "distinguished service to naval ordnance development," the Navy Bureau of Ordnance, through Vice-Admiral G. F. Hussey, Jr., has announced presentation of the Naval Ordnance Development Award to Battelle Memorial Institute, Columbus, Ohio. In addition, some forty members of the Battelle staff have received individual awards for special parts played in prosecution of research on naval ordnance, undertaken for the institute's program.

*Design drawing of new buildings planned for expansion of present manufacturing facilities of Caterpillar Tractor Co., Peoria, Ill.*



# OUTLINE FOR CHAPTER EDUCATIONAL COMMITTEES

EVERY CHAPTER of A.F.A. is considering the promotion of some phases of the National Educational Program. Outlined in the January 1946 issue of AMERICAN FOUNDRYMAN, this program suggests educational and promotional activities to be carried on by individual chapters, national committees and by the A.F.A. National Office. Some new chapters and others previously not active in the educational field have formed committees which are studying local educational possibilities. Chapters experienced in educational work are reviewing their programs and correlating them with country-wide foundry educational activities.

### Committee Functions

Chapter educational committee functions may be broad and varied, and will depend to a considerable extent on the size and type of foundries in the community, the educational institutions in the chapter area, the attitude of the general public, the interest of management, and the availability of other industrial jobs. Possibly the only factor common to all chapter and national educational committees is the necessity for carrying on an unceasing, continuous campaign to educate and interest the public in foundries as a place to work, and castings as an essential medium of construction and manufacture.

A distinction must be made between the functions of an educational committee and the activities carried on by a committee for a chapter educational course. Primarily, an educational committee is expected to sell the foundry industry to the general public and to prospective foundry workers of all types. The purpose of a chapter educational course committee is to organize a series of educational lectures or other educational functions for the benefit of chapter members, who are already working in the foundry industry. Both purposes may be served by the same committee, but this is not advisable unless the chapter is assured that neither function will suffer because of the dual responsibility.

### Educational Committee Essential

A chapter educational committee is essential to adequate and continued advancement of A.F.A. educational work. Local foundrymen are in the most satisfactory position to deal with local problems.

Continuous local contact can be maintained only by a chapter committee constantly on the alert for a chance to advertise the foundry industry. Coverage may be sporadic and incomplete if the task of promoting the National Educational Program is left entirely to national committees or the A.F.A. National Office.

Successful and continuous promotion of the foundry industry is a tremendous advertising job which requires the combined efforts of the 8300 members of the A.F.A., spearheaded by chapter educational committees.

Organizing an educational committee is the first step to be taken by A.F.A. chapters in their educational campaign. Such a committee should consist only of members who are seriously interested in the work to be performed. There can be no honorary members on an educational committee. Included should be one or two representatives of local educational institutions. If cooperation with an engineering school is to be part of the educational program, a representative of the local engineering college should be a member of the committee. Membership may include school superintendents, school board members, school teachers, civic leaders, union officials, and need not be confined to A.F.A. members, although A.F.A. membership is desirable. Use should be made of anyone interested and willing to contribute to the advancement of the foundry industry.

### Chapter Assistance

Able assistance in promotion can be secured from the advertising departments of the larger foundries. Anyone making a hobby of working with young people may be induced to take part in educational committee activities.

After a chapter educational committee has been formed, and officers elected, the A.F.A. National Office should be informed of the personnel. This is essential to keeping the committee informed of national developments in the educational program, particularly those which immediately affect the individual chapter.

Having been formed, a chapter educational committee should study manpower needs of foundries in the community, the attitude of the public toward foundrywork and foundryworkers, and the local market for

castings. A review of the educational articles which have appeared monthly in AMERICAN FOUNDRYMAN since the beginning of 1946 will be helpful in this study. Many educational activities found successful by other chapters are reported in this series.

If an educational committee is already functioning the effectiveness of its activities should be considered from the point of view of (1) immediate needs and (2) long term requirements. Immediate needs generally are for workers to meet current production demands. This requires recruiting activities of several types. Long term call for a program of education and advertising reaching adults, college students, and school children, as well as more immediate prospects for foundry employment.

Some chapters have traditional educational activities which have been valuable for a number of years in directing attention to the casting industry. Activities such as apprentice contests, special meetings for students and apprentices, essay contests, and foundry visits for school teachers and parents, have been reported in recent issues of AMERICAN FOUNDRYMAN.

### Repetition

In considering the repetition of an educational activity used in previous years, its effectiveness must be weighed in the light of present conditions which may be different from those of the past. Repetition is frequently desirable, as shown by certain advertising techniques used in literature and on the radio. However, activities should not be repeated after their value has been lost merely because it is an easier way to carry on.

Many chapters will want to start new educational projects or modify old ones to take advantage of helpful material rapidly becoming available. This new material is being developed with the assistance of chapter educational committees, by national committees, and others.

Ready for distribution is a pamphlet entitled "The Foundry Is a Good Place to Work." This has been enthusiastically received by A.F.A. members and was successfully used in recruiting and advertising recently in Erie. The pamphlet was widely distributed to parents at the Northwestern Pennsylvania chapter's foundry show June 5-7. Use also was made of the pamphlet in booths manned by representatives of the Veterans' Administration and the United States Employment Service.

### Pamphlet Outlets

Other outlets for this pamphlet are employment bureaus, foundries, libraries, veterans bureaus and schools. In chapter areas distribution will be through local educational committees. Where chapters are too far away to handle distribution, pamphlets will be mailed to schools after approval of state educational commissioners.

"The Foundry Is a Good Place to Work" will be followed by other pamphlets expected to appeal to various student and adult groups. These pamphlets are discussed in the April issue of AMERICAN FOUNDRYMAN.

Special A.F.A. educational motion pictures, contemplated for some years, seem likely to become available. A list of films ready for immediate use can be obtained from the A.F.A. National Office. These films have been useful in chapter educational courses, plant training courses and for showing to school groups, clubs, societies, etc.

The national A.F.A. committees dealing with engineering school problems are developing several aids for chapter educational committees. These are expected to be ready for use in time for the fall school term of 1946. Details will be announced in a later issue of AMERICAN FOUNDRYMAN.

An important activity for a chapter educational committee is to supply newspapers with news stories. Poorly developed by most chapters, this phase of public education should receive more attention. It is valuable because newspapers are read by more people, and more types of people, than can be reached by any other single educational medium, or activity.

### News Source

Educational committees can act as a source of news for the local papers, and also for the A.F.A. National Office. In the latter case news releases will be distributed nationally where they will be most effective. Whether the news is primarily of local or national importance, two principles should be kept in mind: (1) turn in news reports promptly, and (2) let the newspapers or the A.F.A. National Office decide what is newsworthy; keep them supplied with all the facts, large and small, whether they seem important or unimportant.

News releases are prepared and sent out from the A.F.A. National Office to trade journals, technical journals and industrial papers, as well as to newspapers.

Special functions of chapter educational committees might include a trip through a modern foundry for a local columnist. Or one of the feature writers on the paper can be interested in oddities of foundry work and human interest items. Periodically, the rotogravure section of newspapers devote a page or two to local industry. Good foundry industry advertising would be a series of pictures showing foundry operations which emphasize cleanliness, good lighting, mechanization, sanitary facilities, and safety.

### Item for Conference

Educational activities of A.F.A. are one of the major items to be considered at the Chapter Chairman Conference in Chicago, July 24-25. Aids and assistance to chapter educational committees outlined above will be discussed at this conference, and local educational plans will be reviewed.

Chapter educational committees can expect increasing assistance from national committees and the A.F.A. National Office. This will enable them to expand their activities and to accomplish more for the foundry industry than in past years. Over the summer, educational committees will be able to reorganize, study local problems, and plan a compaign to start in the fall of this year.

## Chapter Chairmen To Meet in Chicago

SCHEDULED FOR July 24-25, Wednesday and Thursday, the Third Annual Chapter Chairman Conference will be held in the Stevens Hotel, Chicago. This annual meeting of chapter chairmen has become an important factor in co-ordinating the national and local activities of the Association.

# GRAY IRON WEAR RESISTANCE

**Comparison of gray irons showing good to bad metal-to-metal wear resistance has proved that variations in microstructure are associated with wear performance. Superior wear and galling resistance of gray iron is achieved with a complete and fine pearlitic matrix with A.F.A. Type A graphite. Coarse pearlite, free ferrite or cementite in the matrix and A.F.A. Types D and E graphite decrease the wear and gall resistance.**

**F. G. Sefing**
International Nickel Co., Inc.
New York

INVESTIGATIONS by Paul Lane[1], E. K. Smith[2], Frank Dost[3], and others have shown that certain microstructures of gray iron are particularly vulnerable in metal-to-metal wear applications. Many of these same investigators also show that certain other gray iron microstructures offer the maximum resistance to wear and galling.

Those structures recognized as having the best wear properties are illustrated in Fig. 1. These may be described as having a fully pearlitic matrix with the A.F.A. Type A graphite. Those gray irons that show unsatisfactory resistance to galling and wear may show varying degrees of one or the other of the structures illustrated in Figs. 2 and 3.

*Scope.* In this discussion, comments are confined to those machine parts which occasionally fail because of differences in the cast iron structure and not because of inadequate lubrication or high bearing pressures, etc. In piston rings, engine and pump cylinders, machine tool ways, etc., it has been found that gray iron parts with random A.F.A. Type A graphite and a fully pearlitic metal matrix perform more satisfactorily than those irons with the structures illustrated in Figs. 2 and 3.

Furthermore, gray irons containing varying amounts of the poorer wearing structures of Figs. 2 and 3 have poorer wear resistance in proportion to the amount of these structures that is exposed to wear. However, a small amount of the vulnerable structure becomes the weak link in the wear resistance of that gray iron. The important feature, therefore, of achieving the optimum wear and galling resistance of gray iron is to provide the desirable structure throughout the metal.

*Gray Iron Structures Vulnerable to Wear.* From the reports of various investigators, and from the writer's experience with piston rings, cylinder liners, machine tool ways, etc., various gray iron structures may be classified in order of their decreasing wear resistance:

*A.* Refined and completely pearlitic matrix with A.F.A. Type A graphite (Fig. 1).

*B.* Coarse pearlitic matrix with A.F.A. Type A graphite.

*C1.* Pearlite with a small amount of free ferrite matrix with A.F.A. Type A graphite (Fig. 3A).

*C2.* Pearlite with a small amount of free cementite matrix with A.F.A. Type A graphite (Fig. 3B).

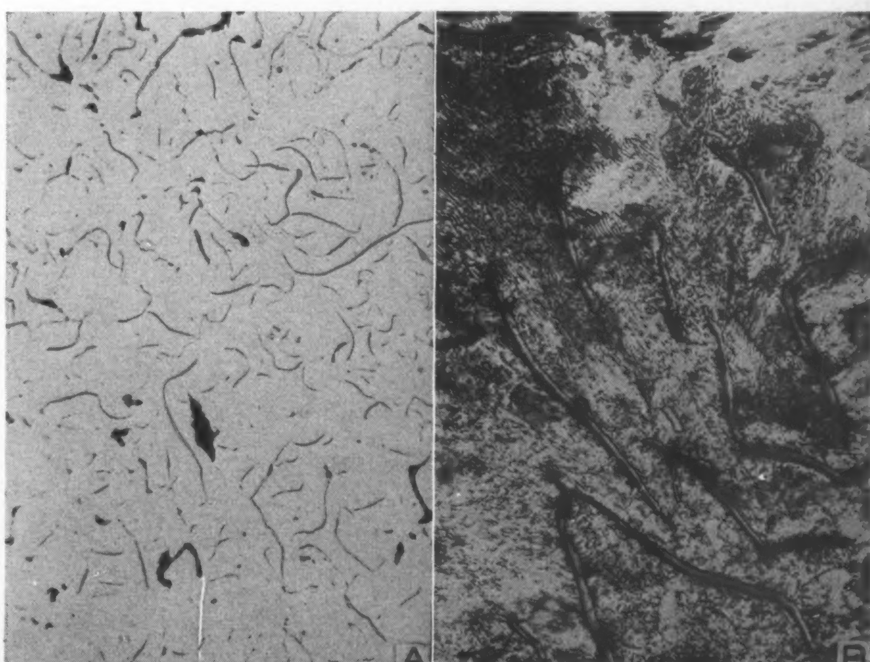
*D.* Abundant ferrite matrix with A.F.A. Type A graphite.

*E.* Abundant free cementite matrix with any form of graphite.

*F.* Secondary ferrite matrix associated with dendritic graphite, A.F.A. Type D or E graphite.

However, this discussion is not so

*Fig. 1 (A)—Desirable graphite structure for wear resistance (A.F.A. Type A). Unetched. 100X. (B)—Fine and completely pearlitic matrix. Nital etch. 500X.*



much on the degree of wear resistance of different gray irons as on preventing the undesirable structures for optimum wear properties in gray iron machine parts.

To achieve a refined pearlitic matrix free of primary ferrite (condition *A*) in gray iron, a minimum of 190-200 Brinell hardness should be aimed for with the use of those alloys which refine the pearlite without tending toward producing cementite. It is obvious that if a coarse pearlite (condition *B*) prevails, the area of ferrite particles exposed to wear can become sufficiently large so that galling or seizure can take place. Therefore, a careful balance of the carbon, silicon and alloys to the casting sections and properties desired will readily maintain the refined and fully pearlitic matrix, provided the graphite structure is proper.

*Fig. 2 (A)—Dendritic pattern of graphite (A.F.A. Type D or E). Unetched. 100X. (B)—Gray iron matrix associated with dendritic graphite. Small white areas are ferrite in small graphite flakes. Nital etch. 500X.*

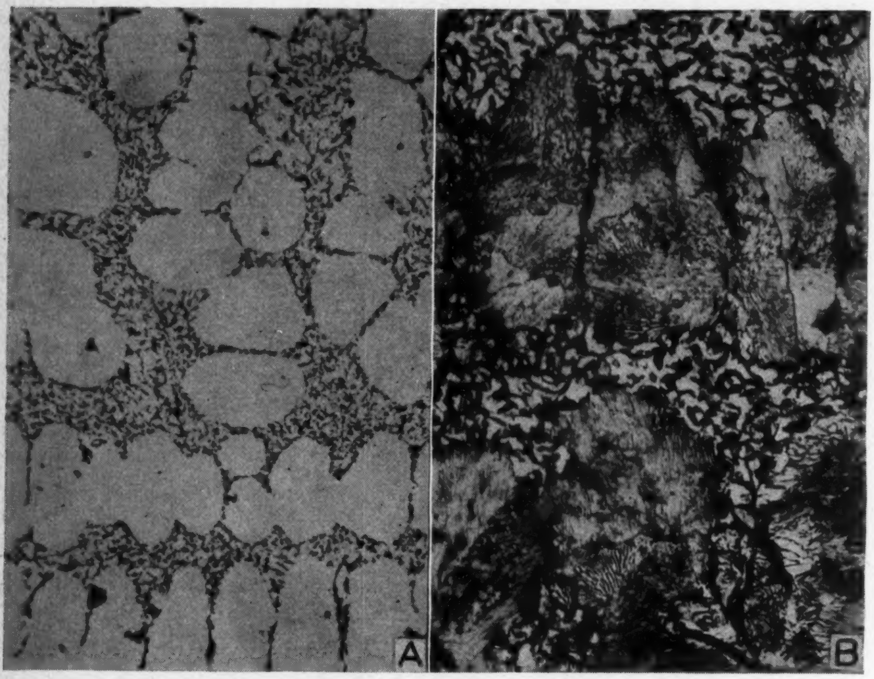
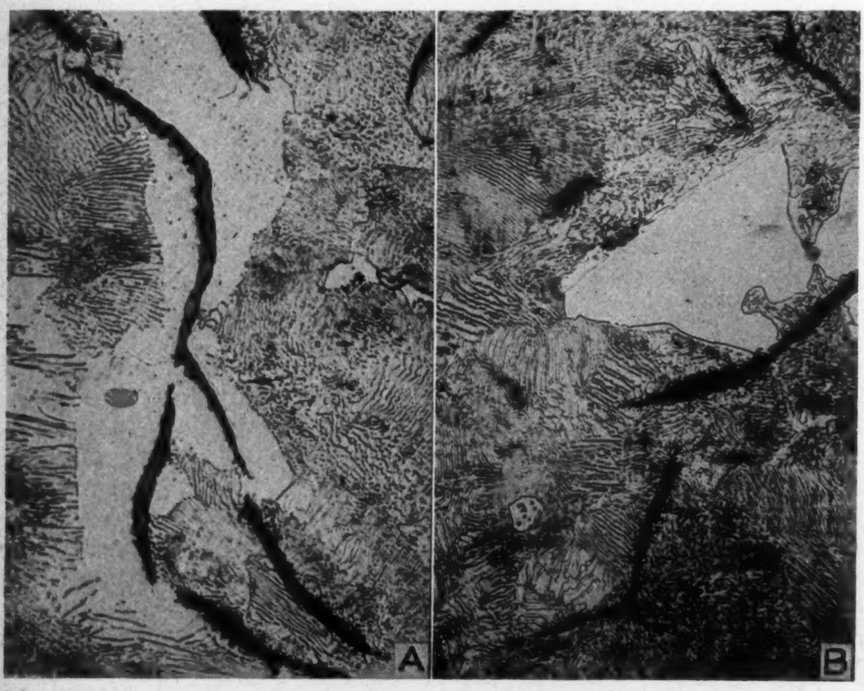


*Fig. 3 (A)—Ferrite (etched white) and pearlite matrix of soft gray iron. Nital etch. 500X. (B)—Cementite (white) and pearlite matrix of hard gray iron. Nital etch. 500X.*



In the foregoing discussion on matrix structure control by means of manipulating the carbon, silicon and alloys, it is pointed out that graphite structure control was not mentioned. However, gray irons with A.F.A. Type D or E graphite structure (Fig. 2A) have strong tendencies to produce matrix structures of Fig. 2B. It is to be noted that the white spots in Fig. 2B are ferrite almost surrounded by small graphite flakes. It is this condition of small metal particles associated with small graphite flakes that is most vulnerable to wear. A study of the influences or factors causing this structure[4]:

1. Increasing chill capacity as affected by the composition.
2. Rapid freezing.
   a. Thin sections.
   b. Low pouring temperatures.
3. Decreasing total carbon and/or increasing steel in melting mixture.
4. Increasing melting temperatures above 2850° F. (superheating).
5. Degree of oxidation during melting. In the order of increasing oxidation effects, melting units can be arranged as follows:
   a. Cupola.
   b. Indirect arc furnace.
   c. Direct arc furnace.
   d. High frequency electric furnace.
   e. Crucible and air furnace.

Factors 1 and 2*a* often are beyond the foundry control, since the composition, design and mechanical properties cannot be changed because of specifications and demand on the castings. Factors 2*b*, 3, 4 and 5, and to some extent factors 1 and 2*a*, can be controlled by suitable foundry practice.

*Control of Desirable Gray Iron Structures.* Fortunately, all of the factors influencing the production of Types D and E graphite can be overcome by careful foundry control, and their effects on graphite structure can be efficiently prevented by adequate inoculation of the metal just before pouring the castings.

Inoculation is a gray iron foundry

term meaning the addition of silicon, or its combination with other metals; iron, nickel, calcium, chromium, etc. From the author's work on inoculation, these late additions have two effects:

1. They provide final deoxidation to melt (very common metallurgical practice, indeed).

2. They provide seeding of the melt with relatively concentrated silicon, which initiates early graphitization during freezing.

The dendritic pattern of Types D and E graphite indicates late graphitization or supercooling[5, 6].

### Inoculant Control

It is obvious that as the potency to produce Type D and E graphite increases, the need for more inoculation or more powerful inoculants increases. The effectiveness of these inoculants in controlling the desired graphite microstructure (Type A) depends upon the type and amount of the inoculant used. The capacity of the iron to become supercooled and to throw Type D or E graphite is dependent upon the influence of the Factors 1 to 5 previously mentioned. The greater this capacity to throw Type D or E graphite, the more inoculant required, for example:

| *Cupola Iron with TC, (per cent)* | *Required Ladle Silicon Addition, (per cent of metal)* |
|---|---|
| 3.20—3.35 | 0.20 |
| 3.00—3.20 | 0.30 |
| 2.75—3.00 | 0.40 |
| 2.50—2.75 | 0.50 |

An iron with 3.25 per cent TC poured into ⅛-in. sections or superheated to 2950° F. may require more than the indicated amount because factors 2*a* and 4 may be more pronounced. One limiting factor must be borne in mind, i.e., the casting skin effect of a few thousandths of an inch will show the Type D or E graphite and cannot be prevented. Since this skin is machined off before placing into metal-to-metal wear service, all the foundryman need do is to add inoculant in sufficient amount and the proper power to hold the undesirable graphite structure to the desired thinness.

A few details about inoculation might be mentioned which the foundryman should bear in mind:

*A.* Temperature of metal inoculated should not be below 2750° F.

*B.* The inoculant should be fused into the metal without burning. Powdered silicon, for example, burns readily with a blue flame and is, therefore, ineffective.

*C.* Adjustment of the composition is necessary to accommodate the ladle addition of silicon and its combined alloys.

With a little experience the foundryman soon learns how much inoculant to add to control the structure of his particular irons in the sections involved.

In the writer's experience with gray irons poured into piston rings, cylinder liners and blocks, machine tool castings, etc., no case has been found where the graphite structure could not be controlled, except in the skin of the castings. This skin effect in extremely light castings has been consistently held to .020 in. with adequate inoculation.

### Conclusion

For superior metal-to-metal wear, it has been shown that gray iron should have a fine and fully pearlitic matrix with A.F.A. Type A graphite. This structure can be adequately controlled with the proper balance of total carbon, silicon and/or alloys, and with adequate ladle inoculation for the metal and castings involved.

Foundries should find no production difficulties, therefore, in meeting a gray iron structure specification for superior wear performance.

### References

1. Paul Lane, "Some Experiences with Wear Testing," TRANSACTIONS, American Foundrymen's Association, vol. 45, p. 157 (1937).

2. E. K. Smith, "Cast Iron Cylinder Bores—Observations on Microstructure, Composition, Hardness and Wear," TRANSACTIONS, American Foundrymen's Association, vol. 48, p. 667 (1940).

3. Frank Dost, "Making Better Machine Tool Castings," *Mechanical Engineering,* vol 62, p. 365, (1940).

4. M. F. Surls and F. G. Sefing, "The Properties of Gray Iron Castings as Effected by Superheating Temperatures," Bulletin 65, 1935, Michigan Engineering Experiment Station, East Lansing, Mich.

5. W. J. Bolton, "Graphitization and Inclusions in Gray Iron," TRANSACTIONS, American Foundrymen's Association, vol. 45, pp. 502-516 (1937).

6. J. T. Eash, "Effect of Ladle Inoculation on the Solidification of Gray Cast Iron," TRANSACTIONS, American Foundrymen's Association, vol. 49, p. 887 (1941).

# SAND TESTING
## *Methods Abroad Show A.F.A. Influence*

INFLUENCE of A.F.A. in foundry sand testing is shown in a recent British publication entitled "Methods of Testing Prepared Foundry Sands."

This is the first report of a joint committee on sand testing made up of representatives of the Institute of British Foundrymen, the British Cast Iron Research Association, the Iron and Steel Institute and the British Non-Ferrous Metals Research Association. Formation of the joint committee resulted from recognition of the need for standardization of tests for foundry molding materials.

Reviewing sand test procedures, members of the joint committee found that A.F.A. methods were most widely used in England and in other countries. Methods and apparatus described in this report are similar to those advocated by A.F.A.

Instructions are given for determining moisture, green permeability and compression strength, and permeability, compression strength and tensile strength in the dry state.

Moisture tests described are the same as commonly used in America. With the exception of the dry tensile strength test, all strength and permeability tests are made on the standard 2 in. $\times$ 2 $\pm$ 1/32 in. test specimen. Dry tensile tests require the usual briquet.

Permeability, defined in this report as in A.F.A. tests, may be determined by any of five pieces of apparatus. Differing only in detail, the five types of equipment all employ a bell-type air reservoir and a manometer. Three of the units may be used for rapid routine tests by employing standard orifices and measuring the pressure.

Apparatus for carrying out compression tests includes two types of tension spring balances, one deadweight tester and a hydraulic tester.

For the dry tensile test the load is applied by allowing shot to run into a container connected to the test briquet by a lever system. Automatically cut off when the specimen breaks, the shot is weighed on a spring balance to determine the unit breaking load.

# OLD TIMERS
## *Gather at Golden Jubilee Convention*

THE OLD TIMERS booth, sponsored by the A.F.A. at the Golden Anniversary Congress, was one of the busiest places at the annual convention. Over the five day meeting 652 men and one woman checked in at the Old Timers booth and were awarded their 25- and 50-year badges. The only woman to register was Mrs. H. V. Adams, assistant manager, Foundry Supplies Mfg. Co., Chicago, who has been in the industry for 27 years.

### Many Register

The records revealed that 70 Old Timers with 50 years or more of service and 583 with 25 years or more of service signed the Old Timers book.

Outstanding record of the Old Timers is that of William Schneider, 84, with 72 years in the foundry industry. He is owner of the Denver Bronze & Brass Co., Denver, Colo., and began his foundry career in 1874 as a brass molder.

Second and third honors went to J. Matthews and John A. Bonnet, respectively. Mr. Matthews, 81½, associated with SPO, Inc., Cleveland, has been active in the foundry industry for 70½ years. Mr. Bonnet, Bonnet Co., Canton, Ohio, is 78, and has been in the industry for 64 years. He started as a molder in 1882 and now has his own company. At the recent Old Timers meeting of the Canton District chapter, Mr. Bonnet was acclaimed the oldest foundryman in that area. (See April AMERICAN FOUNDRYMAN, pp. 175 and 178.)

### '96 Delegate Honored

Arthur E. Barlow, Sachs Barlow Foundries, Inc., Newark, N. J., who attended the first A.F.A. Convention in 1896 and who was awarded an A.F.A. Life Membership at the 1946 convention, registered in the Old Timers book. Mr. Barlow, who is 78, has had 61 years experience in the foundry industry.

A record for long time service in the related industry, belongs to Geo. F. Pettinos, Sr., Geo. F. Pettinos, Inc., Philadelphia. He is 83 and has for 59 years been active in the foundry sand industry.

*A popular spot at the convention was the Old Timers booth where 653 persons registered and received their 25 and 50 year badges for continuous service in the foundry industry. (Left)—Secretary Emeritus R. E. Kennedy places a 25 year badge on the coat of Mrs. H. V. Adams, Foundry Supplies Mfg. Co., Chicago. (Center)—A. E. Barlow who attended the first A.F.A. convention in 1896. (Right)—William Schneider whose 72 years represented the longest foundry service record at the Golden Anniversary Congress.*

## X-ray Safety Code Now Available

FOUNDRIES using x-ray equipment, or anticipating its installation, will be interested in a complete set of safety rules recently approved and published by the American Standards Association.

The new safety code consists of 60 pages of information on every phase of industrial radiography. Bound in heavy paper and containing tables and illustrations, the document covers use and storage of radium, x-ray protection, protection from radiation from the smallest machines up to those employing two million volts, and electrical protection.

Single copies are available at $1.50, with a graduated price scale as low as $0.50 for 1000-copy lots. American Standard Safety Code for the Industrial Use of X-rays may be obtained from American Standards Association, 70 East 45th Street, New York 17.

## Reports on Canadian Nickel Industry Role

ADDRESSING SHAREHOLDERS on occasion of the annual meeting of International Nickel Co. of Canada, Ltd., at Ontario, April 26, Robert C. Stanley, chairman and president, described the firm's contributions to the victorious war effort, its current readjustment and excellent personnel relations; and painted a bright future of expanding application of nickel.

In the course of his remarks, Mr. Stanley revealed that the company produced one and one-half billion pounds of nickel for United Nations —mining a tonnage of ore equal to that mined by the firm and its predecessors in the preceding fifty-four year period—during the war. Average annual production of the metal was increased from 192 to 292 million pounds.

Discussing market outlook, the company chairman noted new applications for nickel developed during the war, increasing tonnage required for production of stainless steel, use of nickel in new high temperature alloys for such developments as the gas turbine, and heavier electroplating with the metal in automotive and electrical industries.

Increase in employee insurance coverage through issuance of nonoccupational policies was reported as Mr. Stanley went on to describe employee relations. Contractual relations with unions were declared generally satisfactory; and highly successful operation of the employee retirement procedure was noted. Specifically cited was cut in accident incidence, and presentation to the firm of the John T. Ryan *"Mine Safety"* award, by Canadian Institute of Mining and Metallurgy.

# JAPANESE FOUNDRY INDUSTRY FOUND INFERIOR

**Charles H. Krause, of Hydro-Blast Corp., recently discharged from the U. S. Navy, inspected the Imperial Navy Yard Foundry at Yokosuka, Island of Honshu, sent the tools and castings illustrated in this article and wrote first-hand reports on foundry methods.**

A. C. Den Breejen
Sand Technician
Hydro-Blast Corp.
Chicago

TONNAGE STATISTICS SHOW that production by the Japanese heavy industry on a full war-time basis never compared favorably with that of our own foundries and factories. The extent to which the Japanese foundry production fell short of typical American foundry production in quality, uniformity, finish, and efficiency of production methods has been clarified by castings, molding tools and sand specimens sent from Japan by Charles H. Krause, formerly Sand Technician, Hydro-Blast Corp., Chicago, with such information about operating methods as he was able to obtain on inspecting the Imperial Navy Yard at Yokosuka.

Here was the pride of the Japanese Empire—the Japanese Imperial Navy. It is safe to assume that the Navy got the best there was to be had—the finest equipment and most advanced ideas which Japan's technicians and production engineers could borrow or develop. If that assumption is correct, it is startling to see from the accompanying photographs how completely Japan was outclassed industrially.

*Description of Plant.* The foundry building at this Imperial Navy Yard at Yokosuka measured approximately 75 by 200 ft., had corrugated sheet metal walls, peaked roof, skylight, and was equipped with electric lighting and running water. A foundry building of such construction would be suitable only for milder climate sections of the United States.

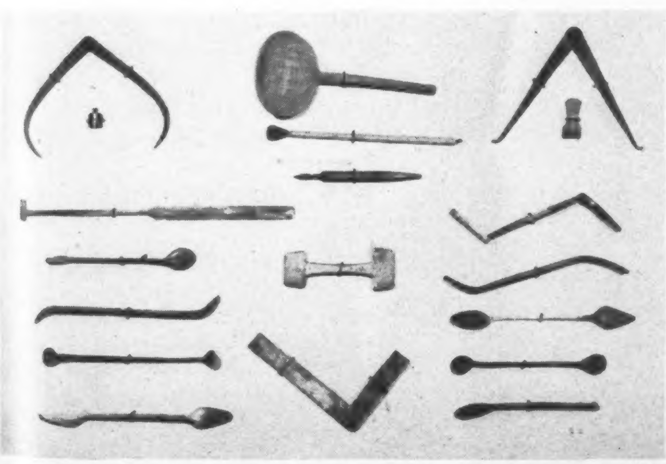
*Description of Plant Equipment.* Shop equipment at this plant consisted of a cupola, several non-ferrous furnaces, a 5-ton electric overhead crane, several hand-powered jib cranes, wooden flasks for heavy castings and snap flasks for smaller castings, and miscellaneous tools such as riddles and shovels similar to those used in American foundries.

## Sand Technique

No evidence of mechanized equipment used for sand preparation and handling was found. There were no sand mullers, belt conveyors, sand cutters, and sand slingers which are standard equipment in American foundries. This indicates that all sand preparation operations were performed manually—most tedious and unpleasant tasks.

Sand used in this foundry ap-

*Fig. 1 (left)—Molder's tools—lifters, double-enders, spoon slicks, hand "tuck-rammer," I.D. and O.D. calipers, square (found to be 1½° off when checked with B & S gage). The 20-gram weight, penholder, lettering brush and inspector's stamp were obtained from "remains" of the laboratory. Fig. 2 (below)—Molder's finishing brushes of goat hair. Note use of bamboo for stem of smaller brushes and packingbox wood for larger brushes. All brushes set in "tin-can binding," nailed or wired for closure.*



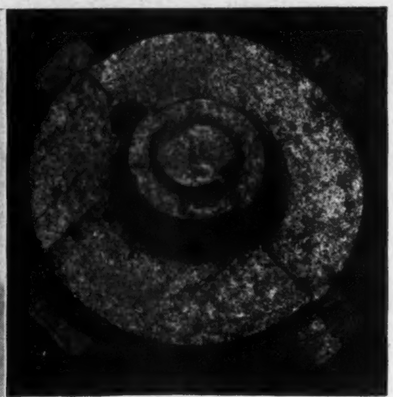


*Fig. 4 (above)—Aluminum casting showing poor surface finish and shift in boss. Photograph shows casting at ½ of actual size.*

*Fig. 3 (left)—Brass castings, probably stopcock valves. Note metal penetration and surface finish. Also, shift is apparent. The larger casting is shown at ½ of actual size and the smaller ¾ actual size.*

peared to be crushed gravel, somewhat similar in character to that used in this country as "opener sand" on heavy steel castings. It was difficult for the observer to determine what methods were used for sand preparation. Apparently all operations were manual. Methods used may have been similar to those used in small jobbing shops in the United States. There was no evidence of any attempt to reclaim sand as has been practiced in this country for the past several years.

*Description of Molder's Tools.* The hand tools used by molders were crude and awkward (Fig. 1). Nearly all were handmade, fashioned from cold rolled stock or cast in iron or brass. Sufficient evidence was found to indicate that as the war years passed the Japanese industry felt increasing pressure due to shortages and was compelled to improvise and make liberal use of substitute materials. Good examples of this are the molder's brushes made of goat hair set in handles made from ordinary packing-box boards or bamboo wood (Fig. 2). These molding tools by comparison with comparable tools used in American foundries appear antiquated and crude, to say the least. They are approximately the same in size but heavier in weight than American tools used in similar applications.

*Description of Product.* Examination of two brass and one aluminum casting made here shows lack of good surface finish, due to the use of sands which allowed metal penetration (Fig. 3). Shifts resulting from poorly made or abused patterns or inferior flask equipment were a common occurrence (Fig. 4). Castings of this quality would never pass even careless inpection in any American foundry.

## A.F.A. Receives Jap Optical Pyrometer

A JAPANESE optical pyrometer was recently given to the A.F.A. National Office by Miles B. Olson, former secretary-treasurer, A.F.A. University of Minnesota Student chapter. Recently discharged from the Navy, Mr. Olson obtained the pyrometer while on duty with the Military Intelligence Section in Japan.

The pyrometer, a disappearing filament type, using a calibrated lamp, rheostat and milliammeter in series, was found in the 1st Japanese Army Research and Experimental Station. A double-range instrument, the pyrometer is a good example of instrumentation and is complete except for battery and objective lens. It is direct reading with maximum scale value of 3500° C.

The research and experimental center from which the pyrometer came is located at Kokubunji, about 25 miles west of Tokyo. Approximately 2½ square miles in area, the grounds were surrounded by a high concrete wall. The buildings, hills, trees and underbrush appeared quite harmless from the air. Looking much like a school, the site was never bombed.

Employees and military personnel attached to the research and experimental station wore civilian clothes and were identified by a distinctive lapel button.

The buildings, most of them constructed of wood, housed all kinds

*Japanese optical pryometer showing general construction and appearance of the instrument. Japanese inscription under the eye-piece bears name of instrument, manufacturer, and model and instrument number.*

of laboratories and experimental equipment.

Much of the equipment and instruments were crude, primitive imitations of apparatus available in other countries. The Japanese used very old photographs and old data in attempting to duplicate apparatus they found necessary.

## Technical Publications Help Educate Many

COLLECTING FOUNDRY publications for distribution to technical schools was started by the Educational Committee, Eastern Canada and Newfoundland chapter last fall. Many foundries receive several copies of AMERICAN FOUNDRYMAN, and other metallurgical and foundry magazines, which accumulate on a plant's desk. These periodicals, and their presence in the classroom, are good advertising, not only for the Association, but for the foundry industry in general.

Chapter educational committees wishing to act as clearing houses for the collection and distribution of foundry and metallurgical magazines will find technical and vocational schools anxious to receive 1945 and 1946 periodicals. Many educational institutions will welcome older issues to replace lost copies and to complete unfinished series. Further, public libraries are often interested in obtaining copies of scientific and technical periodicals.

### Veterans Interested

Another outlet for technical magazines is the Army and Navy hospitals in which convalescing service men avidly read anything related to engineering and science. Chapter educational committees should arrange for distribution of extra copies of AMERICAN FOUNDRYMAN and other foundry periodicals to nearby veterans' hospitals. Any Army post, recruiting center or veterans administration office can supply the names of veterans' hospitals in the chapter area to which chapters can direct foundry literature.

Other technical magazines are also welcomed by hospitals. Journals in the field of metallurgy, mechanical engineering, management, agricultural engineering, electronics and welding are in greatest demand.

Servicemen preparing to return to civilian life following discharge from the hospitals are often engaged in evaluation of job opportunities. The literature describing foundry careers, as well as technology, should be made available to them; and chapter educational committees might also consider methods of following up cases where interest is aroused. Visits to chapter meetings and to local foundries might be arranged to round out presentation of opportunities.

## Improvised Foundry Served Air Transport

VERSATILE FOUNDRY TECHNOLOGY solved an urgent health problem for the Army Transport Command, when Sgt. Claude R. Strickland, a foundryman attached to a French West African base, devised a unique foundry to produce aluminum castings needed for a power duster to eliminate malaria-bearing mosquitos, as reported in *Popular Science*, March 1946.

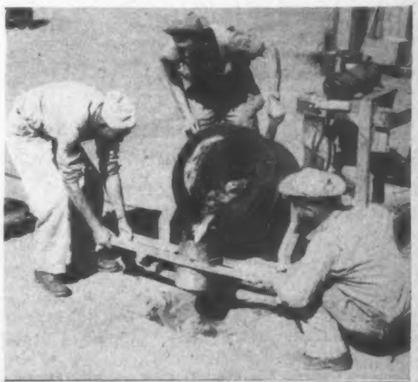
Destruction of the mosquitoes was imperative, and, with no power duster available, it was necessary to build one. However, dampness warped wooden parts, which were tried first, out of shape; and metal components were needed. A foundry to produce metal castings was the only answer.

### Manufactures Equipment

Cutting an oil drum in half, Sgt. Strickland lined it with clay to a thickness of 4 in., leaving a hole in the side to receive the burner, and fashioned a top which fitted tightly yet allowed gases to escape through an opening. An air compressor joined with a home-made oil torch supplied heat of approximately 2300° F. for the completed furnace unit.

A bucket was fitted with handles to serve as a ladle, and wooden shipping boxes were used as flasks. Wood patterns were cut, and the urgently needed aluminum parts successfully cast.

Following elimination of the mosquitoes—and with them the threat of malaria—the foundry was found so valuable in casting metal parts for a variety of applications at the air base that it was kept in operation until the close of the war.



*Some aspects of ingenious foundry in French West Africa: At left, general view, showing air compressor (left), furnace made from oil drum, and (at extreme right) ladle. Set up for manufacture of wooden patterns is seen in second photo from left. Upper right, pouring metal from trunnion-mounted oil-drum furnace into ladle; and, bottom right, casting in drag of wood flask.*

# FOUNDRY PERSONALITIES

**E. G. Huffschmidt,** Western Foundry Co., **A. R. Prier,** Oregon Brass Works, and **W. R. Pindell,** Northwest Foundry & Furnace Works, Inc., all members of Oregon A.F.A. chapter, have been elected vice-president and trustees, respectively, of United Metal Trades Association of Oregon, organization of foundry, machine and pattern shop, and steel fabricating plant operators in the Portland area. Mr. Pindell is Chairman, and Mr. Prier Secretary, of Oregon chapter.

**A. J. Edgar** has announced his resignation as technical advisor, Gray Iron Founders' Society, Washington, D. C. Mr. Edgar, who has been associated with the society since 1942, is well known to A.F.A. as a member of several national committees, including the Executive and Program and Papers committees, Gray Iron Division.

**B. R. Hitpas,** recently discharged from military service, has joined the staff of E. F. Houghton & Co., Philadelphia.

**F. M. Robbins,** president, Ross-Meehan Foundries, Chattanooga, Tenn., announces promotions of: **K. J. Harris,** secretary and treasurer,

K. J. Harris

H. L. Suplee

to vice-president, in addition to his present title; and **H. L. Suplee,** assistant sales manager, to vice-president in charge of sales. Mr. Harris joined the firm in 1926 as auditor, and advanced to assistant secretary-treasurer in 1937, and secretary and treasurer in 1942. Mr. Suplee began his association with the company in 1935 as an estimator, and was made assistant sales manager in 1945.

**M. G. Sedam,** director of research, Alloy Rods Co., York, Pa.,

M. G. Sedam

has been appointed vice-president in charge of research and production, **E. J. Brady,** company president, has announced. Member of American Society for Metals and American Welding Society, in which he serves as Chairman, York-Central Pennsylvania Section, Mr. Sedam has been associated with the Ferrous Metallurgical Advisory Board and National Research Council.

**F. N. Rundquist** and **John Rundquist,** owners, Beloit Castings Co., Beloit, Ill., have announced plans for an addition to the plant, which manufactures gray iron castings.

**J. E. Sweet, Jr.,** recently released from the armed forces and associated with Yoko Corp., York, Pa., as foundry metallurgist, prior to military service, is one of the incorporators of the new firm, Tioga County Foundry Corp., which will build a gray iron foundry at Owego, N. Y. Mr. Sweet will serve as president. Other principals are: **A. R. Cooke,** vice-president and treasurer; and **Mrs. J. E. Sweet, Jr.,** secretary. Mr. Cooke was connected with Wright Aeronautical Corp., Paterson, N. J., before entering the armed forces in 1940.

R. W. Hathaway

**R. W. Hathaway,** formerly plant superintendent, Marine Div., Federal Mogul Corp., Greenville, Mich., has been appointed works manager, Cadillac Malleable Iron Co., Cadillac, Mich. Member of A.F.A., Mr. Hathaway serves as Chapter Director, Western Michigan chapter.

**L. B. Knight,** Lester B. Knight & Associates, Chicago, has been awarded a Citation by the Navy Bureau of Ships in recognition of his services in performance of duties "requiring not only technical proficiency, but also imagination and initiative" while specializing in foundry and forge matters for the Bureau.

H. M. Rich

**H. M. Rich, Jr.,** manager New York district, Electro Metallurgical Sales Corp., New York, has been appointed division manager, New York and Birmingham territories, according to an announcement by

E. C. Mathis  Amicus Most

W. E. Remmers, company vice-president. Mr. Rich will continue to make his headquarters in New York.

**E. C. Mathis,** president, Matam Corp., Long Island, N. Y., and **Amicus Most,** general manager, Parkway Foundry Co., New York, are principals in formation of a new company, Parkway Foundry & Machine Corp., Brooklyn. Occupying a new plant at 59 Paidge Ave., the firm will manufacture non-ferrous sand, permanent mold and centrifugal castings.

Mr. Mathis, as president of the Matam firm, has operated large foundries in production abroad of the "Mathis" car, and Ford, Lincoln and Mercury cars. Mr. Most has devoted most of his life to foundry work, was associated with his father in formation of General Bronze Corporation, Long Island, and organized the original Parkway company, which has been liquidated to make way for the new organization.

**J. H. Anderson,** recently released after 26 months in the Army, has been appointed instructor in foundry practice, University of Minnesota, Minneapolis. Mr. Anderson, who formerly served as Chapter Secretary-Treasurer, A.F.A. student chapter at the University, holds a degree in metallurgical engineering from that school, and had been associated with Diamond Iron Works, Minneapolis, prior to entering military service.

**Harry Dietert Co.,** Detroit, is now concentrating all efforts on sand research and on sales and manufacturing of sand testing and carbon and sulphur determinators; while **Applied Research Laboratories,** of the same city, takes over sales and service of all A. R. L.-Dietert spectrometric equipment.

**Emil Gathmann, Jr.,** formerly sales engineer, Gathmann Engineering Co., Baltimore, Md., is president; **C. G. Stephens,** formerly control manager, Glen L. Martin Co., of the same city, is vice-president; and **M. R. Kennedy,** assistant to president, Gathmann Engineering Co., is secretary, of Gathmann Industrial Corp., newly organized firm of metallurgical consultants and manufacturers representatives, Baltimore 2. Other associates are: **Holden Houghton,** chief mechanical engineer; and **A. R. Stargardter, W. Wade Moss** and **W. H. Burroughs,** metallurgists.

J. G. Paule

**Dr. N. E. Woldman** has established general consulting practice in metallurgical and chemical engineering, under the firm name, Norman E. Woldman, Inc., 356 North Mountain Ave., Upper Montclair, N. J. As noted recently in AMERICAN FOUNDRYMAN, Dr. Woldman, who served as first Chairman of A.F.A. Aluminum and Magnesium Division, resigned his position as chief metallurgical engineer, Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., to enter private practice.

**J. F. Conroy, III,** has been discharged after 44 months service with the U. S. Coast Guard, and has resumed his position as president, National Magnesium Corp., New York. Mr. Conroy has announced appointment of **John Alico,** formerly associated with the engineering staff of Singmaster & Breyer, New York, metallurgical and chemical engineering consultants, as director of research and development for the National Magnesium company. Member of ASM, ASME, and AIME, Mr. Alico is author of the recently published textbook, "Introduction to Magnesium and Its Alloys." (Reviewed on p. 104.)

F. W. Faery

**J. G. Paule,** secretary-treasurer, Wilson Foundry & Machine Co., Pontiac, Mich., has been elected to the board of directors, **H. J. Leonard,** chairman of the board, has announced. Mr. Paule will continue to serve as secretary-treasurer.

**F. W. Faery,** formerly sales engineer, Park Chemical Co., Detroit, has been appointed Michigan engineering and sales manager for Alloy Casting Co., Champaign, Ill. Mr. Faery will make his headquarters at 720 Maccabees Building, Detroit 2.

**L. L. Andrus,** vice-president in charge of sales, American Foundry Equipment Co., Mishawaka, Ind., has revealed several territorial changes and appointments: **D. G. Taylor,** associated for past two years with sales engineering at the home office, has been named sales representative for San Francisco Bay area, with headquarters in San Francisco. **John Getzen,** until re-

D. G. Taylor  John Getzen

*(Continued on Page 98)*

# ★ NEW A. F. A. MEMBERS ★

(Covering the Period from April 15 to May 15)

**• This new members list was brought about through the combined efforts of 31 Chapter Membership Committees. A total of 236 names have been added to the Association's role, including 28 new members which are listed in the "outside of chapter" territory. Illinois continues to dominate the top positions as Central Illinois claims first honors with 29 new applications. Chicago with 18 new members, including two company memberships, is second highest; while Northeastern Ohio ranks third with 17 new men, including one company membership.**

*Conversion—Personal to Company.*

***C. W. Olson Mfg. Co., Minneapolis. (Carl W. Olson, Jr., Fdry. Mgr.)**

## BIRMINGHAM DISTRICT CHAPTER

S. C. Baldone, Jr., Met., Stockham Pipe Fittings Co., Birmingham, Ala.
K. R. Daniel, American Cast Iron Pipe Co., Birmingham, Ala.
Dan B. Dimick, Jr., Dimick Casting Co., Birmingham, Ala.
C. K. Donoho, Plant Met., American Cast Iron Pipe Co., Birmingham, Ala.
Roy E. Duncan, Mgr., Southern Foundries, Old Hickory, Tenn.
Chas. A. FitzGerald, Jr., Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.
J. E. Getzen, Sales Engr., Whiting Corp., Birmingham, Ala.
***Johnson City Foundry & Machine Works, Inc., Johnson City, Tenn. (Porter R. Stewart, V. P.)**
W. E. Jones, Chief Engr., Stockham Pipe Fittings Co., Birmingham, Ala.
J. W. Keller, Mgr., Keller Foundry Co., Knoxville, Tenn.
W. J. Meriwether, Jr., American Cast Iron Pipe Co., Birmingham, Ala.
Fred S. Middleton, Jr., Ass't to Pres., Jackson Industries, Inc., Birmingham, Ala.

## CANTON DISTRICT CHAPTER

William C. Jenkin, Co-Mgr., J & F Casting Co., Cleveland.
Watson Johnson, Gen. Fdry. Supt., Pitcairn Co., Barberton, Ohio.
Frank M. Kochy, Draftsman, Pitcairn Co., Barberton, Ohio.
John B. Larsen, Iron Roll Met., Continental Foundry & Machine Co., Wheeling, W. Va.

## CENTRAL ILLINOIS CHAPTER

Earl D. Biddison, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
Henry F. Cakora, Owner, Tazewell Machine Works, Pekin, Ill.
W. J. Campbell, Fore., Caterpillar Tractor Co., Peoria, Ill.
Donald Chapin, Planning Dept., Caterpillar Tractor Co., Peoria, Ill.
L. Curry, Fore., Caterpillar Tractor Co., Peoria, Ill.
E. Endsley, Fore., Caterpillar Tractor Co., Peoria, Ill.
Gottlieb Grant, Fore., Caterpillar Tractor Co., Peoria, Ill.
J. W. Gri 's, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
Luther G. Gunn, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
C. Hess, Fore., Caterpillar Tractor Co., Peoria, Ill.
T. C. Hamlin, Mgr., Midwest Foundry Supply Co., Edwardsville, Ill.
Lawrence Kinsinger, Apprentice, Caterpillar Tractor Co., Peoria, Ill.
Wayne Malott, Fore., Caterpillar Tractor Co., Peoria, Ill.
D. E. Manley, Salesman, Manley Sand Co., Rockton, Ill.
John G. Miller, Fore., Caterpillar Tractor Co., Peoria, Ill.
H. Neptun, Fore., Caterpillar Tractor Co., Peoria, Ill.
J. D. Rathbun, Fore., Caterpillar Tractor Co., Peoria, Ill.
Gerald W. Rein, Apprentice, Caterpillar Tractor Co., Peoria, Ill.
Gerald Rowe, Fore., Caterpillar Tractor Co., Peoria, Ill.
Alfred Schneider, Caterpillar Tractor Co., Peoria, Ill.
C. W. Search, Fore., Caterpillar Tractor Co., Peoria, Ill.
John W. Smith, Fore., Caterpillar Tractor Co., Peoria, Ill.
Carl B. Stone, Fore., Caterpillar Tractor Co., Peoria, Ill.
Vern W. Swango, Fore., Caterpillar Tractor Co., Peoria, Ill.
William E. Tharp, Gen. Fore., Caterpillar Tractor Co., Peoria, Ill.
H. F. Trumpey, Fore., Caterpillar Tractor Co., Peoria, Ill.
W. B. Vest, Fdry. Planning, Caterpillar Tractor Co., Peoria, Ill.
Carl W. Wade, Training Supv., Caterpillar Tractor Co., Peoria, Ill.
C. R. Wilson, Fore., Caterpillar Tractor Co., Peoria, Ill.

*Company Members.

## CENTRAL INDIANA CHAPTER

A. L. McColloum, Sales Mgr., National Malleable & Steel Castings Co., Indianapolis.
N. H. Motsinger, Pres., Alexandria Foundry Inc., Marion, Ind.
Ralph S. Poulsen, Mgr., Metal Engineering Co., Indianapolis.
Paul E. Price, Mat'ls Engr., Naval Ordnance Plant, Indianapolis.
Edward Wood, Fore., Faultless Caster Corp., Evansville, Ind.

## CENTRAL NEW YORK CHAPTER

Fred L. Guyette, New York Air Brake Co., Watertown, N. Y.

## CENTRAL OHIO CHAPTER

Victor B. Bethany, Met., Alten's Foundry & Machine Works, Lancaster, Ohio.
R. E. Fisher, Jr., Bonney Floyd Co., Columbus, Ohio.
A. C. Judd, Mgr., The Oak Hill Fire Brick Co., Oak Hill, Ohio.
L. C. Midlam, Pres., General Casting Co., Monal, Ohio.
J. F. Mooney, Jaeger Machine Co., Columbus, Ohio.
Paul Ritzer, Owner, Franklin Brass Foundry, Columbus, Ohio.

## CHESAPEAKE CHAPTER

Geo. P. Delaney, Fore., U. S. Naval Gun Factory, Washington, D. C.
Robert S. Durling, Pres., Glen Arm Casting Co., Inc., Glen Arm, Md.
Elwood Harold House, Apprentice, Norfolk Naval Shipyard, Portsmouth, Va.
Harry Layne, Pattern Fore., Lynchburg Foundry Co., Lynchburg, Va.
H. G. Stults, Sales, Pennsylvania Foundry Supply Co., Philadelphia.

## CHICAGO CHAPTER

Karl Blom, Supt., Lindgren Foundry Co., Batavia, Ill.
Julian D. Cox, Works Mgr., Alumicast Corp., Chicago.
***Foundry Products, Chicago. (Murford Gruhlke, Owner)**
Harold G. Haines, Met., Howard Foundry Co., Chicago.
J. Horsfield, Fdry. Supt., Allied Steel Castings Co., Harvey, Ill.
Morris Horwitz, Lt. (j.g.), U. S. Navy, Maywood, Ill.
John E. Lindgren, Lindgren Foundry Co., Batavia, Ill.
W. A. Morey, Universal Castings Corp., Chicago.
Steve J. Pacak, Appr. Patternmaker, Howard Foundry Co., Chicago.
Alfred E. Porte, Plant Mgr., Howard Foundry Co., Chicago.
***Kankakee Foundry Co., Kankakee, Ill. (E. C. Schneider, Partner)**
H. J. Sprecken, Jr., Ass't Fdry. Supt., International Harvester Co., Chicago.
Carl Straychek, Supt., National Bearing Metal Div., American Brake Shoe Co., Chicago.
A. B. Tincher, Mgr. Ind. Div., Kerkling & Co., Chicago.
Richard Wetstein, Appr. Patternmaker, Industrial Pattern Works, Chicago.
John F. Wisniewski, Jr., Apprentice, Link Belt Co., Chicago.
John F. Wooddell, Ass't Supt., Hansell-Elcock Co., Chicago.
John T. Zayner, Foundry Met., International Harvester Co., Chicago.

## CINCINNATI DISTRICT CHAPTER

***Auburn Foundry, Inc., Auburn, Ind. (Wm. Buckholtz, Works Mgr.)**
Conrad W. Hansen, Pres., LaCon Pattern Works, Inc., Dayton, Ohio.
Carl M. Lyons, Supt., American Rolling Mill Co., Ashland, Ky.
Martin E. Rollman, Engr., Cincinnati Milling Machine Co., Cincinnati.
Donald W. Whitehead, Sales Engr., Electro Refractories & Alloys Corp., Buffalo, N. Y.

## DETROIT CHAPTER

Russell Wayne Callard, V. P., The Foundries Materials Co., Detroit.
D. E. Champion, Engr., Albion Malleable Iron Co., Albion, Mich.
Fitz Coghlin, Met., Albion Malleable Iron Co., Albion, Mich.
William J. Esdale, Supt., Briggs Mfg. Co., Detroit.
Robert W. Mason, Jr., Foundry Met., International Nickel Co., Detroit.
Karl E. Ness, Met., Gorham Tool Co., Detroit.
***O'Halloran Industrial Castings Co., Detroit (E. P. O'Halloran, Pres.)**
Kenneth W. Perkins, Met. Engr., Ford Motor Co., Dearborn, Mich.
A. R. Prout, Corn Products Sales Co., Detroit.
Edward A. Rutt, Fact. Mgr., Commerce Pattern, Foundry & Machine Co., Detroit.
R. E. Rutzen, Gen. Fdry. Supt., Wilson Foundry & Machine Co., Pontiac, Mich.

O. A. Van Sickle, Supt., City Pattern Foundry & Machine Co., Detroit.
Douglas J. Strong, Pres., Foundries Materials Co., Coldwater, Mich.

## EASTERN CANADA & NEWFOUNDLAND CHAPTER

Fernand J. U. Beaudoin, Fore., Canadian Car & Foundry Co. Ltd., Montreal, Que.
James K. Campbell, Patternmaker, Canadian Vickers Ltd., Montreal, Que.
P. Von Colditz, Train. Fore., Canadian Car & Foundry Co. Ltd., Montreal, Que.
George Fleury, Molder, Northern Foundry Ltd., Montreal, Que.
Donat Gauthier, Coreroom Fore., Northern Foundry Ltd., Montreal, Que.
John B. Hinds, V. P., St. Lawrence Alloys, Inc., Malone, N. Y.
Arthur R. Neufeld, Dominion Engineering Works, Lachine, Que.

## METROPOLITAN CHAPTER

Martin J. Conroy, Fdry. Estimator, Eclipse-Pioneer Foundries, Bendix Aviation Corp., Teterboro, N. J.
Charles H. Fetzer, Ass't Fdry. Fore., International Nickel Co., Inc., Bayonne, N. J.
R. L. Greenamyer, Serv. Engr., Master Tool Co., Inc., Cleveland.
Stanley R. Keith, Tech. Dir., Submergent Alloys Corp., New York.
Thomas K. Russell, Jr., Apprentice., American Brake Shoe Co., New York.
***Fairview Foundry, Poughkeepsie, N. Y. (Fred M. Selinger, V. P.)**
Richard M. Strayer, Mgr., Fairview Foundry, Poughkeepsie, N. Y.
Theo. J. Voll, Met., Metals Distintegrating Co., Elizabeth, N. J.
***Thatcher Furnace Co., Garwood, N. J. (William J. White, Supt.)**

## MEXICO CITY CHAPTER

Juan Codina, Engr., Cowen S, de R. L., Mexico, D. F.
Santos Letona, Supt., Fundicion el Rosario, Puebla.
Ing. Rafael Ortega Varela, Supt., Comision Federal de Electricidad, Mexico, D. F.

## MICHIANA CHAPTER

***The N. P. Bowsher Co., South Bend, Ind. (John Hager, Prod. Engr.)**
Frances J. Kaufman (Mrs.), Lakeside Foundry Co., Warsaw, Ind.
***The Dalton Foundries, Inc., Warsaw, Ind., (C. H. Ker, Gen. Supt.)**
William F. Lange, Jr., Casting Service Corp., LaPorte, Ind.
Leslie Pugh, Casting Service Corp., LaPorte, Ind.

## NORTHEASTERN OHIO CHAPTER

P. Andell, Sec'y-Treas., Anchor Foundry Co., Bedford, Ohio.
Louis C. Baker, Gen. Mgr., Columbiana Pump Co., Columbiana, Ohio.
Frederick K. Barb, Supv., Forest City Foundries Co., Cleveland.
Louis A. Barrett, Chief Insp., Aluminum Co. of America, Cleveland.
William R. Beck, Gen. Sales Mgr., The Atlantic Foundry Co., Akron, Ohio.
Rex P. Beckwith, Salesman, Hines Flask Co., Cleveland.
R. M. Fisher, Salesman, Pig Iron, American Steel & Wire Co., Cleveland.
John M. Fox, Met., Aluminum Co. of America, Cleveland.
***Anchor Foundry Co., Bedford, Ohio. (S. S. Goldstein, Pres.)**
Melville E. Kohler, Sales, Scientific Cast Products Corp., Cleveland.
Orville R. Lehman, Salesman, Cuyahoga Foundry Co., Cleveland.
J. James Parker, Estimator, Aluminum Co. of America, Cleveland.
Peter Rettig, Owner, Rettig Pattern Co., Cleveland.
Warren L. Robinson, Prod. Mgr., The Duplex Mfg. & Foundry Co., Elyria, Ohio.
J. K. Rossborough, Partner, Rossborough Supply Co., Cleveland.
Albert W. Tokar, Supv., Forest City Foundries Co., Cleveland.
Charles F. Walton, Fdry. Engr., Meehanite Metal Corp., Cleveland Heights, Ohio.

## NORTHERN CALIFORNIA CHAPTER

Charles V. Nyland, Molder, Mare Island Navy Yard, Mare Island, Calif.
George A. Shaw, Ass't Mgr., Palmquist Foundry, Oakland, Calif.

## NO. ILLINOIS - SO. WISCONSIN CHAPTER

Raynard E. Anderson, J. I. Case Co., Rockford, Ill.

## NORTHWESTERN PENNSYLVANIA CHAPTER

William P. Bender, Gen. Fore., General Electric Co., Erie, Pa.
Frederick R. Lange, Owner, Shenango Pattern Works, Sharon, Pa.
R. R. McClintic, Ind. Engr., Oil Well Supply Co., Oil City, Pa.
Richard G. Miller, Open Hearth Met., American Locomotive Co., Latrobe, Pa.

## ONTARIO CHAPTER

Robert Anderson, Modern Aluminum & Brass Co., Toronto, Ont.
A. M. Bilbrough, Tor. Mgr., Mussens Canada Ltd., Toronto, Ont.
J. Dalby, Mgr., Wilson Brass & Aluminum Foundries, Toronto, Ont.
J. T. Feldcamp, Owner, Quality Brass Foundry, Toronto, Ont.
William Searle, Fdry. Supt., W. Sherratt & Son, Toronto, Ont.
Harry G. Stead, Gen. Mgr., E. Leonard & Sons, London, Ont.
George Wilson, Apprentice Patternmaker, Anthes-Imperial Ltd., St. Catharines, Ont.

## OREGON CHAPTER

O. K. Buckner, Pur. Agent, Electric Steel Foundries, Portland, Ore.
Chas. L. Case, Pur. Agent, Crawford & Daherty Foundry Co., Portland, Ore.
Joe Minardi, Supt., Peninsula Foundry & Machine Works, Portland, Ore.
Bernard W. Franzwa, Pacific Steel Foundry, Portland, Ore.
***Peninsula Foundry & Machine Works, Portland, Ore. (George Johnson, Supt.)**

## PHILADELPHIA CHAPTER

Randolph Charrington, Sales Mgr., North American Smelting Co., Philadelphia.
Charles M. Fehr, Tech. Sales Service Engr., Pennsylvania Salt Mfg. Co. Philadelphia.
John L. Furey, Sales Mgr., Swan & Finch Oil Corp., New York.
William A. Hoffman, Gen. Mgr., Bridesburg Foundry Co., Philadelphia.
Joseph A. Keeth, Pur. Agent, Pennsylvania Steel Castings Co., Chester, Pa.
R. M. Kellert, Serv. Repr., Aluminum Co. of America, Pittsburgh, Pa.
Major Liu Kiang-Min, Chinese Army Ordnance Corps, Pittsburgh, Pa.
G. M. Beard, Fdry. Fore., Read Machinery Co., York, Pa.
Hyman Rosenthal, Met., Frankford Arsenal, Philadelphia.
John Snyder, Met. Engr., E. I. du Pont de Nemours & Co., Wilmington, Del.
Paul E. Stallman, The Savill Co., Philadelphia.
A. Paul Thompson, Senior Fellow, Mellon Institute, Pittsburgh, Pa.
Vincent I. Varga, Contact Met., Bethlehem Steel Co., Bethlehem, Pa.
William Wilde, Fore., Baldwin Locomotive Works, Eddystone, Pa.

## QUAD-CITY CHAPTER

J. G. Burg, Owner, Purity Moulding Sand Co., Dallas City, Ill.
P. J. Schmitz, Owner, Ideal Chaplet Works, Rock Island, Ill.

## ROCHESTER CHAPTER

Gilbert L. Cox, Mgr., The International Nickel Co., Inc., Rochester, N. Y.
John C. Kress, Ass't Chief Insp., The Symington-Gould Corp., Rochester, N. Y.
A. O. Pieper, Pres., Heavy Ind. Cramie Corp., Rochester, N. Y.

## SAGINAW VALLEY CHAPTER

Richard W. Heine, Inst., General Motors Institute, Flint, Mich.
Raymond J. Maenner, Met., Dow Chemical Co., Midland, Mich.

## ST. LOUIS DISTRICT CHAPTER

William James Barnett, Grad. Student, Missouri School of Mines & Metallurgy, Rolla, Mo.
William Henry, Fdry. Supt., Fulton Iron Works, St. Louis.

## SOUTHERN CALIFORNIA CHAPTER

I. O. Frantz, Owner, Frantz Pattern & Foundry Co., Long Beach, Calif.
***Kerkling & Co., Burbank, Calif. (F. A. Kormann, Vice Pres.)**
William F. Nash, Jr., Met., Naval Ordnance Test Station, Pasadena, Calif.
Homer L. Romine, Plant Engr., Pacific Cast Iron Pipe & Fittings Co., Southgate, Calif.
Joel Silen, Patternmaker, Mattson Pattern Shop, Monterey Park, Calif.
Edwin J. Worth, Westlectric Steel Castings, Inc., Los Angeles.

## TEXAS CHAPTER

Jess A. Reeves, Sales Engr., Hill & Griffith Co., Birmingham, Ala.
R. J. Rice, Mgr., Texas Field Section, International Nickel Co., Inc., New York.

## TWIN-CITY CHAPTER

Ernie C. Carlson, Fdry. Fore., C. W. Olson Mfg. Co., Minneapolis.
Italo Marsano, Student, Fundicion "Callao," Minneapolis.
A. J. Salg, Supt., Alloy Metals Co., St. Paul, Minn.

## WESTERN MICHIGAN CHAPTER

Frank Boutell, Fdry. Supt., Montague Castings Co., Muskegon, Mich.
Eugene L. Boyden, Coreroom Fore., Montague Castings Co., Muskegon, Mich.
Jack C. Breyer, Ass't to Gen. Mgr., Montague Castings Co., Muskegon, Mich.
Nelson Damm, Engr., Pyle Pattern & Mfg. Co., Muskegon Heights, Mich.
I. K. MacGregor, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Joseph S. Mogdis, Supv., Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Douglas C. Noble, Quality Control, Sealed Power Corp., Muskegon, Mich.
Ernest Olson, Fdry. Supt., The Challenge Machinery Co., Grand Haven, Mich.

## WESTERN NEW YORK CHAPTER

Robert G. Cady, Engr., Ajax Flexible Coupling Co., Inc., Westfield, N. Y.
C. Ray Hanlin, Serv. Engr., Master Tool Co., Inc., Cleveland.

## WISCONSIN CHAPTER

R. W. Foxwell, Ass't Engr., J. I. Case Co., Racine, Wis.
W. A. Hambley, Jr., Student, University of Wisconsin, Madison, Wis.
Fred G. Kramer, Engr., Modern Foundry, Milwaukee.
Willis Mielke, Fdry. Tech., Allis-Chambers Mfg. Co., Milwaukee.
Gilbert G. Strehlow, Ass't Mgr. of Purchases, Perfex Corp., Milwaukee.
Clarence Ultsch, Fdry. Fore., Nelson Bros. & Strom Co., Racine, Wis.

*Company Members.

**OUTSIDE OF CHAPTER**

S. G. Bentley, Fdry. Supt., Malleable Iron Fittings Co., Branford, Conn.
Edward D. Boyle, Master Molder, Foundry, Puget Sound Naval Shipyard, Bremerton, Wash.
R. E. Buchanan, Fore., Aluminum Co. of America, Cleveland.
R. L. Cobb, Prod. Supt., Bethlehem Supply Co., Tulsa, Okla.
R. Mayo Crawford, V. P., Turner & Seymour Mfg. Co., Torrington, Conn.
F. A. Hartgen, Supt., Malleable Iron Fittings Co., Branford, Conn.
E. B. McPherson, Owner, McPherson's Aluminum & Brass Foundry, Denver, Colo.
Howard O. Schmidt, Met., Aluminum Co. of America, Fairfield, Conn.
*Washington Stove Works, Everett, Wash. (William L. Mackey, Vice Pres.)
Stewart B. Whitney, V. P., Laconia Malleable Iron Co., Laconia, N. H.

**Belgium**

Robert Doat, Engr., Cie Generale des Conduites d'Eau, Les Vennes-Liege, Belgium.

**Canada**

Jas. A. Dickson, Owner, Dickson Foundry Co., Vancouver, B. C., Canada.

**China**

Liu, Chin-Yi, Chinese Eng. Student, Tientsin, China.
Chin-Chien Chow, Ass't Chief Engr., China Electric Steel Works, Kunming, China.

**Czechoslovakia**

L. Jenicek, D. Sc., Czechoslovakio National Steel Corp., Prague, Czechoslovakia.

*Company Members.

**Denmark**

Denmarks Tekniske Bibliotek, Copenhagen, Denmark.

**England**

Alfred Jackson, Director, Garton & King Ltd., Exeten, England.

**France**

Edward Dussourd, Vonvillain et Ronceray, Choisy le Roi, France.
Roger Lafarge, Director, Sterla, Colombes (Seine), France.
Societe De Chimie Industrielle, Paris VIIeme, France.

**New Zealand**

E. J. Carroll, Met., New Zealand Government Railway Workshops, Wellington, N. Z.

**Norway**

Aksel Arstal, Man. Dir., Foss Jernstoperi, Oslo, Norway.
Johan Gorrissen, Ph.D., Christiania Spigerverk, Oslo, Norway.
John Sissener, Cons. Engr., Myrens Verksted, Oslo, Norway.
Carl Edward Torp, Met., Christiania Spigerverk, Oslo, Norway.

**Portugal**

Sebastiao Augusto Campos, Fdry. Engr., Fabricas Vulcano e Colares, Lisbon, Portugal.

**Scotland**

Tom Shanks, Cruckshank & Co. Ltd., Denny, Scotland.

**Sweden**

Yngve E. Frid, Chief Engr., Akers Styckebruk, Sweden.

# WORLD CONGRESS
## Of Foundrymen Urged

INITIAL STEP toward closer international relations between foundrymen was taken during the Golden Jubilee Convention in Cleveland, when an informal meeting as held by representatives of groups affiliated with the International Committee of Foundry Technical Associations, which regulated International Congresses and fostered international relations and good-will between such organizations until the outbreak of war.

Result of the discussion was adoption of a resolution to send out a call for a meeting of official representatives later in the year, which would discuss formation of a new International Congress.

Present at the informal meeting in Cleveland were: F. J. Walls, *President,* American Foundrymen's Association; Tom Makemson, *Secretary,* Institute of British Foundrymen, and original *Secretary,* International Committee of Foundry Technical Associations; Vincent Delport, A.F.A. representative on the International Committee; Dr. Ladislav Jenicek, *Official Delegate,* Czechoslovak Foundrymen's Association; Marcel Debrock, member, French Foundrymen's Association; J. H. Ubbink, Foundry Association of Holland; M. Remy, Foundry Association of Belgium; F. G. Steinebach, *Chairman,* A.F.A. International Relations Committee; W. W. Maloney, *Secretary,* American Foundrymen's Association.

### Text of Resolution Adopted at Cleveland

RESOLVED, THAT: —A letter be sent to the foundry technical associations of the friendly nations that were affiliated with the International Congress of Foundry Technical Associations before the war, recommending that they appoint an official representative, with a view of attending a meeting, later in the year, to discuss the formation of a new International Congress of Foundry Technical Associations. The committee would have for its objects:

The fixing of the calendar of world and other international congresses;

The regulation of exchange papers to be presented at these congresses;

The exchange of publications between the affiliated technical associations;

All other matters conducive to the closest collaboration between foundry technical associations.

The associations will also be asked to suggest matters to be placed on the agenda of the proposed meeting.

*Discussing, at the 1946 meeting of A.F.A., the formation of a new International Congress to foster international relations between technical associations were these men (seated, left to right): Tom Makemson, Fred Walls and M. Remy. Standing in the back row (left to right): J. H. Ubbink, Marcel Debrock, Dr. Ladislav Jenicek, Frank Steinebach, Vincent Delport, and Wm. W. Maloney. The above resolution to be sent to technical associations is the result of this group's work.*

# ★ CHAPTER ACTIVITIES ★

# news

## Texas

UNDER LEADERSHIP OF Texas A.F.A. chapter—headed by Chairman E. P. Trout, Lufkin Foundry & Machine Co., Lufkin, Texas, who handled arrangements and presided at the rally held at Lufkin High School football stadium—a great throng of foundrymen and friends from the industrial Southwest gathered in Lufkin for the April 18 chapter meeting.

Following the meeting at the stadium, which highlighted an address by Robert LeTourneau, LeTourneau Co. of Georgia, Toccoa, Ga., L. E. Roark, executive vice-president, National Founders Association, Chicago, and ex-Congressman Martin Dies of Lufkin spoke to a group of seven hundred attending a barbecue at Lufkin Country Club in the evening.

Leading industrialists of Texas, as well as from adjoining territory, were in attendance for the occasion, many arriving in the morning in order to tour local industries. Cooperating in arrangements was the Southwestern regional office, National Association of Manufacturers, Dallas.

Mr. LeTourneau was introduced by Mr. Roark, a lifelong friend, and the former presented a discussion of "Values." Spiritual and material values were compared by the speaker, who recommended that spiritual values be placed first in business and everyday living.

Preceding Mr. LeTourneau, E. M. Taylor, of recently-established LeTourneau Technical Institute of Texas, Longview, spoke briefly concerning the Institute's publication *"Now"*.

### Personnel Relations

Addressing the evening gathering at the Country Club, Mr. Roark discussed personnel relationships, and cited production records of labor under stress of war conditions. Supervision, he suggested, must find methods of maintaining production levels in peacetime comparable to those of war years.

The following speaker, Mr. Dies, also stressed improvement of relationship between employer and employee, and noted the high standard of living attained by American labor through development of our economic system.

## Michiana

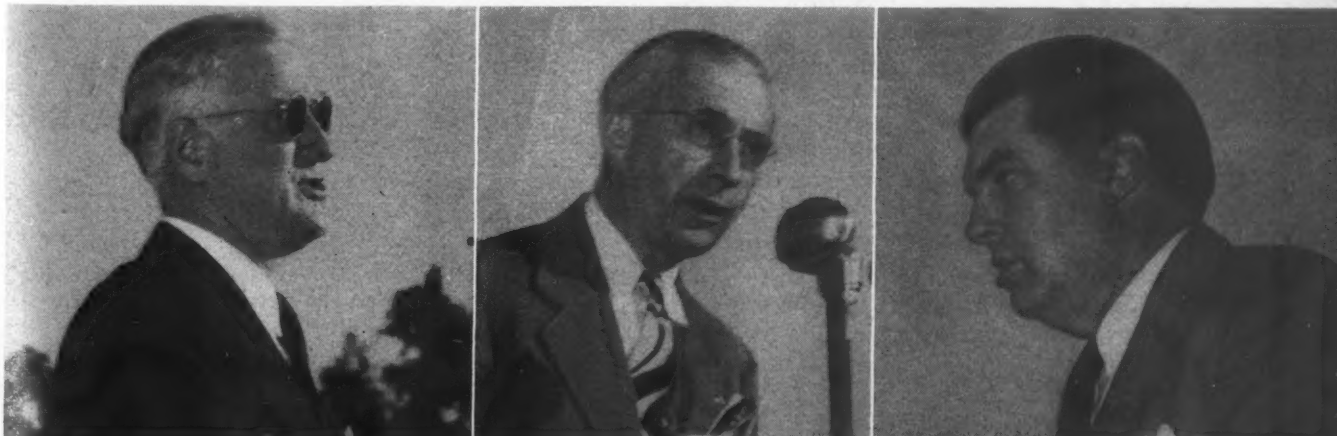
**V. S. Spears**
**American Foundry Equipment Co.**
**Chapter Secretary-Treasurer**

TAKING UP the selection of new officers and directors, Michiana A.F.A. chapter, meeting April 2 at the Hotel La Salle, South Bend, Ind., chose as its *Chairman* for the coming year, John McAntee, Covel Manufacturing Co., Benton Harbor, Mich., who served as Chapter Vice-Chairman for 1945-46.

Elected as *Chapter Vice-Chairman* was J. H. Miller, Josam Products Foundry Co., Michigan City, Ind., whose term as Chapter Director expires this year. V. S. Spears, American Foundry Equipment Co., Mishawaka, Ind., continues as *Chapter Secretary-Treasurer*.

Elected *Chapter Directors* were: term expires 1948, John Rush, Elkhart Brass Manufacturing Co.,

*Among key speakers at the big Texas chapter meeting in Lufkin, April 18, were (left to right): L. E. Roark, executive vice-president, National Founders Association, Chicago; E. M. Taylor, LeTourneau Technical Institute, Longview, Texas; and Texas Chapter Chairman E. P. Trout, Lufkin Foundry & Machine Co., Lufkin.*



*Hyman Bornstein (right), Deere & Co., Moline, Ill., past A.F.A. National President and 1946 A.F.A. Gold Medalist, who was speaker at the April 15 meeting of Central Illinois chapter, has informal discussion with Chapter Chairman L. E. Roby, Peoria Malleable Castings Co., Peoria, Ill., and Miss Alva Cleary, foundry training secretary, Caterpillar Tractor Co., Peoria.*

Elkhart, Ind., replacing John McDonald, Round Oak Furnace Co., Dowagiac, Mich., who has transferred from the chapter; terms expire 1949, I. S. Peterson, Premier Furnace Co., Dowagiac; William Ferrell, Auto Specialties Manufacturing Co., St. Joseph, Mich.; G. E. Garvey, City Pattern Works, South Bend; and S. F. Krzeszewski, American Foundry Equipment Co.

Appointed by the Chairman to head chapter committees were the following Directors: *entertainment,* H. B. Voorhees, Dodge Manufacturing Corp., Mishawaka; *program,* Earl Byers, Sibley Foundry & Machine Co., South Bend; *membership,* I. S. Peterson; and *publicity,* S. F. Krzeszewski.

## Northern California

**C. R. Marshall**
**Chamberlain Co.**
**Chairman, Publicity Committee**

FEATURING A SPECIAL non-ferrous program, with John Selfridge, Federated Metals Div., American Smelting & Refining Co., San Francisco, discussing "Metallurgy of Brass and Bronze" and L. D. Alpert, of the same firm, leading a round table discussion, the Northern California A.F.A. chapter held its April 12 meeting at the Engineers Club, San Francisco; Chapter Chairman Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco, presiding during the initial portion of the meeting, and program chairman, Chapter Director A. M. Ondreyco, Vulcan Co., Oakland, taking charge for the technical sessions.

Mr. Selfridge covered in a comprehensive manner the melting, fluxing and alloying of non-ferrous metals; and described furnace types in use and fuels common to the chapter area, as well as considering relationship of various gases to metal quality and pointing out desirability of slightly oxidizing condition in furnace atmosphere.

Referring to seven groups of alloys —many of which alloys have been developed for special applications— the speaker expressed the opinion that there are too many types, and that simplification would benefit the industry. Skill required in sorting scrap metal for proper segregation was cited. The speaker went into some detail in describing principal alloys in general use.

During the round table discussion under Mr. Alpert's direction, much interest centered on gassing of metal; metallurgists present advancing scientific opinions, while practical foundrymen presented their viewpoints and raised questions on various aspects. General discussion was enthusiastic and sustained on this subject, and such others as: pouring temperatures, moisture—in ladle linings, sand, and as a combustion by-product—fluxes, atomic hydrogen, carbon and corrosion.

## Connecticut Non-Ferrous

PRESENTING a sound technicolor film, "Sand," before the Connecticut Non-Ferrous Foundrymen's Association, meeting at the Hotel Taft, New Haven, April 17, W. R. Slater, Whitehead Bros. Co., Providence, R. I., precipitated a lively discussion on natural versus synthetic sands.

The educational film was interesting and thorough, depicting geological origin of the material and its history from deposit to distribution for industrial application. Shown were: loading, grading, treating, refining, testing and storing prior to shipment.

Included in the discussion which followed showing of the film was consideration of equipment necessary to manufacture synthetic sand in the foundry. Consensus of opinion after lively interchange of comment was that synthetic sands require careful supervision and control; and that small foundries not thoroughly equipped—especially as regards control—were best advised to use natural sands.

It was advocated that equipment maintained for sand control be such as to permit complete determinations when necessary in addition to routine tests.

## Cincinnati District

**J. S. Schumacher**
**Hill & Griffith Co.**
**Chapter Vice-Chairman**

SELLING SERVICE STRENGTH of castings to the user is of vital importance to foundrymen, J. B. Caine, Sawbrook Steel Castings Co., Cincinnati, told Cincinnati District A.F.A. chapter members at the April 8 meeting, in that city's Engineering Society Headquarters, as he presented a discussion on "What Is Strength."

Mr. Caine, member Committee on Producing Steel for Castings, A.F.A. Steel Division, dealt with newer con-

cepts of strength, relating to ability to perform in service rather than tensile strength. Foundrymen actually sell this service performance—the casting itself is just so much dead weight—the speaker pointed out. All foundrymen know, he added, that castings possess this important characteristic; their job—which can and must be done—is to convince the purchaser.

Presiding at the meeting, which was marked by attendance of 100, was Chapter Chairman A. W. Schneble, Sr., The Advance Foundry Co., Dayton, Ohio.

*(Photo courtesy Akron Beacon Journal)*

*At the April 18 meeting of Canton District chapter, Chapter Vice-Chairman I. M. Emery, Massillon Steel Casting Co., Massillon, Ohio, nominee for 1947 Chapter Chairman, "rings the bell," held by Chapter Vice-Chairman C. F. Bunting, Pitcairn Co., Barberton, Ohio.*

## Twin City

**Paul Hesse**
**Union Brass & Metal Mfg. Co.**
**Chapter Reporter**

Dropping the toga of new responsibility upon capable shoulders, 78 members of Twin City A.F.A. chapter, meeting April 18 at the Curtis Hotel, Minneapolis, elected the following officers for the coming year:

*Chairman,* H. M. Patton, American Hoist & Derrick Co., St. Paul, Minn., who served as Vice-Chairman for the 1945-46 season; *Vice-Chairman,* S. P. Pufahl, Paul Pufahl & Son Foundry, Minneapolis, following a term of service as Chapter Director.

Chosen to continue as *Secretary-Treasurer* was Alexis Caswell, Manufacturers' Association of Minneapolis, Inc., Minneapolis.

Speaker of the evening on "The Use of Bronze" was A.F.A. National Director G. K. Dreher, Ampco Metal, Inc., Milwaukee. Mr. Dreher, a member of the Executive Committee, A.F.A. Brass and Bronze Division, commanded the interest of the foundrymen, especially with his remarks concerning gating and risering of bronze castings.

At the conclusion of the speaker's remarks, a motion picture, "Golden Horizons," was shown by courtesy of the Ampco Metal Company.

*Chapter election night (April 18) for Twin City A.F.A. chapter found these groups gathered: Bottom, left to right, retiring Chapter Chairman R. C. Wood, Minneapolis Electric Steel Castings Co., Minneapolis; Chapter Chairman-Elect H. M. Patton, American Hoist & Derrick Co., St. Paul, Minn.; National Director G. K. Dreher, Ampco Metal, Inc., Milwaukee; National Vice-President (since, President-Elect) S. V. Wood, Minneapolis Electric Steel Castings Co.; and Chapter Vice-Chairman-Elect S. P. Pufahl, Paul Pufahl & Son Foundry, Minneapolis. Top, Chapter Director Clifford Anderson (third from right) pauses for camera during informal chat.*

## Canton District

**N. E. Moore**
**Wadsworth Testing Laboratory**
**Chapter Reporter**

Round table discussions of iron and steel, with Chapter Director K. F. Schmidt, United Engineering & Foundry Co., Canton, Ohio, leading the former and Chapter Director F. K. Donaldson, Machined Steel Castings Co., Alliance, Ohio, the latter, comprised the technical program for the April 18 meeting of Canton District A.F.A. chapter, at Mergus Restaurant, Canton.

An added feature of the meeting, as at others throughout the past year, was the coffee talk by Conrad Traut, Hoover Co., Canton, on "Job Relations School." Mr. Traut's discussion was the last in a series which chapter members have found interesting and instructive.

On hand for the discussions were 70 members and guests, who also heard the recommendations of the chapter nominating committee.

Speaker of the evening for the

*Leader of the annual non-ferrous session of Central New York chapter, April 12, at Syracuse, N. Y., was Anthony Cristello (third from left), Bendix Aviation Corp., Teterboro, N. J., member Executive Committee, A.F.A. Aluminum and Magnesium Division; shown here with (left to right): Chapter Vice-Chairman E. E. Hook, Dayton Oil Co., Syracuse; Chapter Director J. F. Livingston, Crouse-Hinds Co., Syracuse; and National Director H. H. Judson, Goulds Pumps, Inc., Seneca Falls, N. Y.*

meeting of the preceding month, March 21, at Mergus Restaurant, was J. M. Kane, chief engineer, Dust Control Division, American Air Filter Co., Louisville, Ky., who discussed "Control of Dust."

Illustrating aspects of his subject with slides, Mr. Kane, considered different types of dust collection systems, air velocities and their relationship to maximum efficiency, and conditions in plants before and after installation of proper facilities. Effects of different types of dust upon health and mental attitude of workers were touched upon briefly.

## Southern California

**J. B. Morey**
**International Nickel Co. Inc.**
**Chairman, Publicity Committee**

TYPE OF WORK at hand should be given due regard in purchase of production equipment, is the advice machine manufacturers are giving foundrymen, according to L. D. Pridmore, International Molding Machine Co., Chicago, who discussed "Molding and Core Blowing Machines" before more than 100 foundrymen and guests present at the April 12 meeting of Southern California A.F.A. chapter, in the Los Angeles Elk's Club, of that city.

In the course of his instructive remarks, the speaker stressed importance of selecting right machines for jobs under consideration; and pointed up desirability of securing the manufacturers' advice, since, he declared, the latter are themselves shouldering responsibility of encouraging foundries to purchase only proper equipment for their requirements.

## Central New York

**J. A. Feola**
**Crouse-Hinds Co.**
**Chapter Reporter**

HIGHLIGHTING THE Central New York A.F.A. chapter's annual non-ferrous meeting of April 12, at the Onondaga Hotel, Syracuse, N. Y., as Chapter Vice-Chairman E. E. Hook, Dayton Oil Co., Syracuse, presided, was discussion of "Comparative Foundry Characteristics of Bronze and Aluminum Alloys," by Anthony Cristello, Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

Mr. Cristello, foundry manager for his firm and member Executive Committee, A.F.A. Aluminum and Magnesium Division, drew from a background of twenty years practical non-ferrous foundry practice for recommendations as to a definite system of gating and risering for good economical operation.

Importance of this aspect of practice was stressed; and the speaker, while admitting that in many cases foundrymen produce sound castings through application of a "pet" method to particular jobs, offered several definite ratios of sprues, runners and gates. The time element as one measure of good gating was suggested—all pouring operations to be timed and checked in pounds per second. Mr. Cristello observed that comparison of results of such time checks indicates rate of metal flow desirable for sound castings, so that runners and gates may be altered accordingly.

Also discussed at length were: selection of proper grades of sand for cores and molds, which involved consideration of grain size, moisture content, etc.; binders and oils for cores, and proper melting and pouring techniques.

In the lively discussion period, foundrymen present raised a number of interesting problems for the speaker's suggestions.

## Eastern Canada - Newfoundland

**G. D. Turnbull**
**Shawinigan Foundries, Ltd.**
**Chairman, Publicity Committee**

DEMONSTRATING VALUE of relatively inexpensive control instruments which do not require highly skilled personnel, and are economically practical for small foundries, the program committee of Eastern Canada and Newfoundland A.F.A. chapter met an apparent important need of local foundries through arrangement of an "Exhibition of Foundry Control Instruments and Methods," presented at the April 12 meeting in Mount Royal Hotel, Montreal.

Chapter Chairman G. E. Tait, Dominion Engineering Works, Lachine, Que., presided at the meeting; and Chapter Director A. E. Cartwright, Robert Mitchell Co. Ltd., St. Laurent, Que., presented a short introductory discourse on value and utility of the devices in attainment of highest quality in foundry products.

Change in program from the group discussion originally scheduled was in response to general feeling in some quarters that scientific and instrumental control is attainable only by large organizations able to procure equipment and trained personnel for its operation. The exhibit was designed to reveal that valuable information for control purposes is within reach of smaller foundries.

Apparatus on display—for temperature and carbon control, hardness testing, sand testing, test bars, fracture tests, quality inspection, identification of metals and alloys, and atmosphere testing—were loaned

by members' companies; and were in operation with one or more consultants available to answer queries.

### Saginaw Valley

**J. J. Clark**
**Saginaw Malleable Iron Div.**
**General Motors Corp.**
**Chapter Director**

HOLDING ITS ANNUAL business meeting May 2, at Frankenmuth, Mich., Saginaw Valley A.F.A. chapter elected officers and directors before adjourning for a technical session featuring an interesting discussion of "Precision Casting," by Morris Bean, Morris Bean Co., Yellow Springs, Ohio.

Elected *Chapter Chairman* for the coming year was John F. Smith, Chevrolet Grey Iron Foundry, Saginaw, Mich., Chapter Vice-Chairman, 1945-46, who assumed the duties of Chairman recently on resignation of H. G. McMurry, now in Australia with General Motors Overseas Div.

Marshal V. Chamberlin, Dow Chemical Co., Midland, Mich., 1945-46 Secretary-Treasurer, has been named *Chapter Vice-Chairman* for 1946-47. Mr. Chamberlin, in addition to his duties as chapter officer has been active in A.F.A. Foundry Sand Research Project as a member of the Physical Properties of Non-Ferrous Sands subcommittee.

Chosen *Secretary-Treasurer* for 1946-47 was Francis S. Brewster, Dow Chemical Co., Bay City, Mich., who served as Chapter Director during the past year. Mr. Brewster has been associated with A.F.A. national activities, as a member of the Sand Shop Operation Course Committee and several groups within the Foundry Sand Research Project, in which he acts as Chairman, Subcommittee on Core Gas and Moisture Absorption.

*Directors* elected to serve three-year terms were: L. L. Clark, Buick Motor Div., General Motors Corp., Flint, Mich.; L. A. Cline, Saginaw Foundries Co., Saginaw; and D. D. Bowman, Almont Mfg. Co., Imlay City, Mich. Also elected *Chapter Director* was J. J. Clark, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, who will serve a one-year term.

Following the business section of the meeting, Mr. Bean held the interest of those present with his discourse on precision castings, which he described as, in general, those which are cast to close tolerances and with fine finish.

Advances and improvements in the two general methods of producing such castings—one employing permanent patterns and the other expendable patterns ('lost wax' method)—were described. The speaker presented a display of samples, illustrating potentialities of this specialized phase of the castings industry.

### Central Illinois

**C. W. Wade**
**Caterpillar Tractor Co.**
**Chapter Secretary**

DISTINGUISHED GUEST SPEAKER before Central Illinois A.F.A. chapter's April 15 meeting at the Jefferson Hotel, Peoria, Ill., was Hyman Bornstein, Deere & Co., Moline, Ill., who presented authoritative information on "Selecting the Correct Material for the Job" to 140 members and guests, assembled under presiding officer, Chapter Chairman L. E. Roby, Peoria Malleable Castings Co., of that city.

Mr. Bornstein, past A.F.A. National President and Director, spoke on the eve of receiving the Wm. H. McFadden Gold Medal of A.F.A. for his outstanding contributions to the foundry industry, at the Annual Dinner in Cleveland, May 10. Recognized as an international metallurgical authority, the speaker delivered a comprehensive analysis of his subject.

Noting that, in most cases, there is a choice of materials and methods of fabrication, the speaker pointed out that the correct choice will produce satisfactory results and services at low cost. Change in material might be indicated by service failures, change in design, or necessity of reducing cost. Study of failed parts—which offer more information than those in successful service—was urged. This point was illustrated by reference to certain actual instances.

The speaker remarked that new designs are frequently based on old

*At the March 12 meeting of the Rochester chapter: Speaker's table (top, left to right), Chapter Director H. B. Hanley, American Laundry Machine Co., Rochester; Chapter President W. F. Morton (seated), The Anstice Co. Inc., Rochester, and Chapter Secretary-Treasurer C. B. Johnson, Symington-Gould Corp., Rochester; speaker of the evening B. L. Simpson (seated), National Engineering Co., Chicago, and Chapter Vice-President W. G. Brayer, Bausch & Lomb Optical Co., Rochester; Chapter Director D. D. Baxter, Sterling Wheelbarrow Co., Rochester; and M. L. Doelman, National Engineering Co. In attendance were (bottom) 22 members of the Symington-Gould supervisory organization.*

*(Photos courtesy Myron DeHollander, Symington-Gould Corp.)*

ones where similar material is used; but, citing recent advances in stress analysis, recommended that stress engineer and metallurgist be consulted on entirely new designs.

Properties and costs were described for: gray iron; white and chilled iron, described as possessing excellent wear resistance and giving fine service when casting is properly designed; malleable iron, cited for good casting properties, ductility, machinability and impact resistance; steel castings, forgings and stampings; non-ferrous alloys; and plastics, with observations on changes in character of synthetic resins after application of heat, and comment by the speaker that, in general, plastics are favored where special properties are required.

In conclusion, Mr. Bornstein stated that most designs are result of experience; and that changes in methods and materials make it desirable to examine designs periodically in view of effect of such developments on costs and performance.

During the general question period, members of the audience raised many important foundry problems for discussion by the speaker and others present. There was general agreement that the technical session had been of unusual value, and Chairman Roby expressed to Mr. Bornstein the gratitude of the chapter.

Earlier, during the business portion of the meeting, J. E. Kolb, Caterpillar Tractor Co., Peoria, as chairman of the chapter nominating committee, presented the slate of officers and directors; and Program Chairman F. W. Shipley, Caterpillar Tractor Co., announced a picnic to be held Saturday, June 8, at Shore Acres Country Club, Chillicothe, Ill.

## Birmingham District

**J. P. McClendon**
**Stockham Pipe Fittings Co.**
**Chairman, Publicity Committee**

WITH ATTENDANCE OF foundrymen and friends in the neighborhood of 100 at the Tutwiler Hotel, Birmingham, Ala., for the April 26 dinner and technical session, Birmingham District A.F.A. chapter heard C. J. Scullin, foundry consultant, St. Louis, Mo., present a timely and enlightening discussion of "General Foundry Practice."

Incorporating observations from his own experiences in a large number of different foundries, the speaker declared that most problems would be solved within the organization concerned—provided proper control of variables and thorough checking of finished products were adhered to rigidly, rather than left dependent on guesswork. Foundries, Mr. Scullin asserted, should prepare now for the day when business would be sought rather than to be had; developing more efficient methods to obtain costs which make foundry business profitable in normal times.

The speaker was introduced by Program Chairman J. A. Bowers, American Cast Iron Pipe Co., Birmingham, to whom Chapter Chairman J. A. Woody, of the same firm, turned over the meeting after presiding at a brief business session. Chapter Director J. T. Gilbert, Stockham Pipe Fittings Co., Birmingham, chairman of the chapter nominating committee, presented the recommendations of that group.

## Northwestern Pennsylvania

**E. M. Strick**
**Erie Malleable Iron Co.**
**Chapter Vice-Chairman**

STUMPING THE EXPERTS proved beyond the resources of approximately 75 members and guests at the April 22 meeting of Northwestern Pennsylvania A.F.A. chapter, in the Moose Club, Erie; with the quizmaster, Chapter Director K. T. Guyer, Cascade Foundry Co., Erie, ruling the contest a draw, and presiding officer Chapter Chairman R. W. Griswold, Jr., Griswold Mfg. Co., Erie, concurring in the decision.

Comprising the "board of experts" who successfully dealt with the questions on a wide variety of foundry topics were: Joseph Shuffstall, National-Erie Corp.; John Clarke, General Electric Co.; Earl Strick, Erie Malleable Iron Co.; Clarence Fitz, Hays Mfg. Co.; Fritz Diemer, Cascade Foundry Co.; Sam Holmes, Chicago Pneumatic Tool Co., all of Erie; and Jack Gill, Lake Shore Pattern Works, Cleveland.

Retarding of solidification of metals was a topic of considerable interest, as was the question of adding water and oil to core sand. In regard to the latter, it was decided after some division of opinion among members of the board, that it makes no difference which is added first.

## Wisconsin

DIVIDING INTO FIVE GROUPS for consideration of various aspects of foundry technology, Wisconsin A.F.A. chapter devoted the evening of April 12 to a highly interesting sectional meeting at the Schroeder Hotel, Milwaukee.

Gray iron group, meeting under chairmanship of W. A. Hambley, Allis-Chalmers Mfg. Co., Milwaukee, member of the Steering and Executive Committees, A.F.A. Gray Iron Division, heard "Recent Developments in Gates and Risers" described by H. C. Winte, Worthington Pump & Machinery Corp., Buffalo, N. Y., who also is prominent in the activities of that Division, as member of Program and Papers, Chill Tests and other committees.

Substituting for group chairman A. F. Pfeiffer, Allis-Chalmers Mfg. Co., who was unable to attend, Chapter Director A. M. Fischer, Chas. Jurack Co., Milwaukee, presided as the pattern group conducted a "Review of the Past Year Sessions of Pattern Advances for the Foundries." M. C. Frankard, Delta Mfg. Co., Milwaukee, served as co-chairman.

"The Practical Use of Dry Binders in Core Rooms" was discussed before the malleable iron session by R. W. Bennett, director of research, Metro-Nite Co., Milwaukee; while Karl Grobschmidt, Badger Malleable & Mfg. Co., of that city, acted as chairman.

In the chair for the steel group meeting as R. C. Panleman, director of industrial relations, Marquette University, Milwaukee, discussed "The Steel Foundryman of Tomorrow," was L. A. Hargrave, Bucyrus-Erie Co., South Milwaukee, Wis. S. D. Mueller, Falk Corp., Milwaukee, was co-chairman.

Technical group and non-ferrous group held a joint session to hear the remarks of W. J. Poehlman, research engineer, A. O. Smith Corp., Milwaukee, on "Practicability of the Spectrograph as Applied to Ferrous and Non-Ferrous Metals." Serving as chairman was L. E. Royt, Allis-Chalmers Mfg. Co.; with John Wiltzius, Nordberg Mfg. Co., Milwaukee, as co-chairman.

# BOOK REVIEWS

*Collected Papers on Metallurgical Analysis by the Spectrograph.* Edited by D. M. Smith. 162 pp., 58 figures. Price $4.23. Obtainable from the British Non-Ferrous Metals Research Association, Euston Street, London, N. W. 1.

For some years past the B.N.F.M. R.A. Sub-Committee on Metallurgical Applications of the Spectrograph has operated through various panels covering different aspects of the work. Apart from guiding the Association's own spectrographic researches the individual members of the panels have also provided results obtained in their own laboratories. In this way a considerable number of reports have been distributed to the B.N.F.M.R.A. membership, some emanating from the Association's own research staff and some from laboratories of member companies.

The present volume contains a selection of thirteen papers based on these various reports: two on the processing and calibration of the photographic plate; four on analysis of zinc alloys; two on copper alloys; and one on platinum. The co-operative nature of this work is shown by the fact that of these thirteen papers, six are from members of the Association's staff, three from member companies, one from a Government Department and three are reports from panels of the B.N.F.M. R.A. Sub-Committee.

The book is not a systematic treatise on the spectrographic analysis of metals and alloys, but many of the papers make practical recommendations on various aspects of technique. The papers cover a wide range and the book will be of great interest to all engaged in the spectrographic analysis of non-ferrous metals.

*Essentials of Industrial Health,* by Dr. C. O. Sappington. Red Cloth bound, 626 pages, 64 illustrations. Price $6.50. Published by J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa.

During the past year considerable emphasis in the foundry industry has been focused on making the foundry a better place to work. In keeping with this trend, it might be well for foundrymen to review some of the principles of industrial health, as set forth in Dr. Sappington's book, written in 1943. The author has assembled fundamental facts and figures which should hold the answer to many industrial health problems.

The book is divided into three parts. In Part One on Industrial Health Administration, everything from history and legislative background to rehabilitation of workers is presented.

Part Two, on Industrial Hygiene and Toxicology, discusses industrial health exposures in abnormalities of air pressure, dust, temperature, humidity, and many other conditions.

Part Three, on Industrial Medicine and Traumatic Surgery, is well developed with industrial accidents, occupational diseases and non-occupational disabilities being discussed thoroughly.

*Foundry Sand and Mold Materials,* Report Number Two, prepared by the Northern California chapter, American Foundrymen's Association, June, 1945. Spring back binding, 164 pages, illustrated with charts and graphs. Price, $2.00.

This book is an example of the highest type of accomplishment possible to a group of foundrymen working together cooperatively.

The members of the Northern California chapter realized the benefits to be had from a comprehensive knowledge of local molding materials and practices. Accordingly, through the medium of chapter subcommittees, they pooled the results of their experience and research and undertook the study of unsolved problems. Their efforts succeeded in raising the standards of products produced, not just by individual foundries, but by the entire foundry industry of the California area.

The book is a practical and comprehensive survey of molding materials obtainable in the California area. Subjects discussed in the book include core mixtures, wet blacking, facing mixtures, and washes which are being used in various foundries; techniques of measuring, and mixing materials; methods cf production, characteristics and adaptability of new local sands; casting defects traceable to sand characteristics and practices; porosities of sands; binders; and countless details which must be observed in successful foundry practice.

*Underground Corrosion,* issued by the National Bureau of Standards, is obtainable from the Superintendent of Documents, Washington, D. C., for $1.25 a copy, by requesting the Bureau of Standard's publieation C-450.

This publication, a cloth-bound book of 312 pages, covers soil corrosion effects on a number of materials, such as pipes and similar products. The investigation started in 1922 with materials buried in various types of soils throughout the country, and periodically examined. The products buried included a number of cast specimens obtained through the cooperation of A.F.A. committees. The specimens included fittings of cast iron, cast steel and malleable cast iron.

The report includes data on specimens that had been buried for a period of 17 to 19 years.

The fundamental causes and processes of underground corrosion are the same as those occurring in the air or water, but their relative values are different. Corrosion in soils is the result of soil characteristics and conditions. However, these are too numerous and complex to permit a satisfactory correlation of corrosion with any single soil property.

The test results of ferrous materials indicate that the commonly used ferrous pipe materials do not differ greatly in their resistance to soils. Their apparent relative merits are either accidental or dependent on soil conditions. Low-alloy ferrous materials lose weight more slowly than unalloyed ferrous materials, but

*(Continued on Page 103)*

# THE USE OF AJAX PHOSPHOR-COPPER

**Send for booklet**
**"INGOT METALS OF TODAY"**

•

**15 STANDARD ALLOYS BY AJAX**

Ajax Tombasil
Ajax Plastic Bronze
Ajax Anti-Acid Bronze
Ajax Phosphor Bronze
Ajax Red Brass Ingots
Ajax Manganese Bronze
Ajax High-Tensile Manganese Bronze
Ajax Golden Glow Yellow Brass
Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
Ajax Phosphor Copper
Ajax Silicon Copper
Ajax Nickel Alloys
Ajax Phosphor Tin

**NOTE**

*"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

Successful foundrymen deoxidize or "clean up" molten metal by a scientific method worth using *as indicated:*

They use phosphorus . . expertly . . in the form of "Ajax Phosphor Copper" . . added as the crucible is removed from the furnace . . for virtually all brass and bronze alloys.

In notched waffle sections, or in shot form, Ajax 15% P-Cu does its work at .01% (1 oz. per 100 lbs.). Introduced, and having time to react when stirred with a whirling motion of the skimmer, it causes oxides to rise for effective removal by skimming from the surface. It is best to avoid phosphorus build-up from back stock.* . . If you use phosphorus these days, use Ajax Phosphor Copper (useful also in producing your phosphor bronze)

**THE AJAX METAL COMPANY**
**PHILADELPHIA**
ESTABLISHED 1880

**ASSOCIATE COMPANIES:**
AJAX ELECTRIC FURNACE CORPORATION, *Ajax-Wyatt Induction Furnaces for Melting*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup Induction Furnaces for Melting, Heating*
AJAX ELECTRIC COMPANY, INC., *Electric Salt Bath Furnaces*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Furnaces*

# "If we'd made this radiograph sooner...

# ...we'd have saved $30,000"

**A manufacturer of valves, whose foundry technic seemed "okay," decided pilot radiographs weren't needed. But when machining was done and the valves assembled, enough were found defective to cause a loss of many thousands of dollars.**

Radiography, put to work at the right time and place, pays off. Men who have figured *cost-wise* what it can do for them . . . to improve design, speed production, and lower costs . . . make full use of x-ray.

Radiographs show your engineers where to correct faulty design . . . how to reduce weight safely . . . how to cut costs at many stages of manufacture . . . how to build in extra dependability.

Order-jammed foundries get a welcome production spurt when radiography shows how to get into sound casting production fast. High-value, high-volume machine shops operate at rock-bottom cost when radiographic inspection keeps internally unsound castings off the production line.

Welding gains acceptance . . . new markets . . . higher volume . . . because radiographs prove weldments sound.

And these are only a few high spots in radiography's list of industrial functions. You can find more—if you look for them—right in your own plant. Why not get together with your radiographer or the local x-ray dealer and see if you are missing any chances to make radiography pay extra dividends? Or write to

**Eastman Kodak Company, X-ray Division**
**Rochester 4, New York**

# Radiography —another important function of photography

Koda

## Foundry Personalities

*(Continued from Page 85)*

cently in charge of Birmingham Ordnance District, with rank of Colonel, has joined **H. G. Mouat,** Birmingham district sales representative. Prior to entering military service, Mr. Getzen was assistant to president, Stockham Pipe Fittings Co., Birmingham, Ala., with which firm he was associated 16 years.

**T. T. Alverson** will be sales representative in the newly created Baltimore, Md., sales office; **D. E. Neustadt** has been named sales representative for the Los Angeles area; and **John Nixon** will have charge of the Atlanta, Ga., sales office.

**H. L. Stein,** president, Interstate Smelting & Refining Co., Chicago, announces appointment of **Benny Friedman** as Detroit sales representative for the firm line of precision quality brass and bronze ingot. Mr. Friedman, recently placed on inactive status with the rank of Lieutenant-Commander after three years duty with the Navy, is internationally known for his football career with the University of Michigan, Ann Arbor, and with the New York Giants of the National Football League.

**W. A. Morey,** recently returned from military service and previously associated with Mann & Brown, Chicago, has joined Universal Castings Corp., Chicago, as consultant, research and development department. Mr. Morey is well known to A.F.A. as a speaker at chapter meetings and member, Recommended Practices on Precision Casting Committee, Brass and Bronze Division, and several other National Committees.

**J. A. Clark,** who served four years with Army Ordnance and was assigned to Watervliet, N. Y., and Watertown, Mass., arsenals as production superintendent and production metallurgist respectively, has joined the operations staff of Vana-

*(Continued on Page 100)*

## Foundry Personalities

*(Continued from Page 98)*

dium-Alloys Steel Co., Latrobe, Pa. Graduate of Michigan College of Mining and Technology, Houghton, Mich., Mr. Clark joined A.F.A. in 1936, and has been an active member of Western New York chapter.

**Sam Tour,** president, Sam Tour & Co. Inc., engineering and metallurgical consultants, announces addition of a department of mechanical engineering to facilities of the company. The new department is in charge of **E. V. Crane,** formerly consultant and chief of development engineering, E. W. Bliss Co., Hastings, Mich., and author of many technical and scientific papers on engineering subjects.

**Burt Perry,** who has been associated for the past 20 years with the automotive field, has joined the staff of Industrial Division, Kerkling & Co., Burbank, Calif., **C. A. Kerkling,** company president, has announced.

**W. R. Kidder,** recently released from the Navy where he was engaged in supply and technical training work, has joined the Los Angeles office of Wilson & Geo. Meyer & Co., San Francisco, manufacturers agents.

**I. H. Mitchell,** formerly associated with Crosley Corporation, Cincinnati, has joined Eutectic Welding Alloys Corp., New York, as advertising manager and director of public relations, according to announcement of **R. D. Wasserman,** president of that firm.

**James Mitchell,** president, Cleveland Foundry Co., Cleveland, has revealed beginning of construction on a $350,000.00 addition to the plant, which will increase production capacity one-third. The firm, a division of Cleveland Co-Opera-

*(Concluded on Page 102)*

## Foundry Personalities

*(Continued from Page 100)*

tive Stove Co., supplies castings to another division, the Grand Home Appliance Co., and to manufacturers in the household appliance, farm equipment and industrial equipment field.

**Gilbert Colgate,** president, Colgate Aircraft Corp., Amityville, Long Island, has announced establishment of an incentive profit sharing plan, whereby 25 per cent of company net profits will be divided among associates in accordance with gross earnings and length of service.

**W. A. Scheuch,** vice-president, Nassau Smelting & Refining Co., Tottenville, Staten Island, New York, has been elected president, succeeding **F. W. Willard,** who has retired as president and member of the board of directors. **G. J. Boileau,** treasurer, has been elected vice-president and will succeed Mr. Willard on the board; while **E. F. Baxter** has been named treasurer, and **E. F. Stoker,** assistant treasurer.

**S. B. Wentz,** president, Pennsylvania Foundry Supply & Sand Co., Philadelphia, announces appointment to the sales department of **H. G. Stults,** who has had many years experience in foundry industry in Eastern Pennsylvania, New York and Maryland.

### Obituary

**William E. Goebert,** general manager and foundry superintendent, Bowler Foundry Co., Cleveland, died May 7 at his home in Cleveland. Member of the Northeastern Ohio A.F.A. chapter, Mr. Goebert served as Chapter Vice-Chairman for the 1944-45 season; and was a member of the Finance Committee for the Golden Jubilee Convention. Mr. Goebert joined the Bowler company in 1939, prior to which he was associated as plant superintendent with Johnson & Jennings Co., Cleveland.

## Book Reviews

*(Continued from Page 95)*

are penetrated by corrosion as rapidly. Alloys high in nickel and chromium are very resistant to corrosion.

In most of the soils investigated, the rate of corrosion of ferrous materials decreases as the exposure is prolonged. Any rate of corrosion is applicable only to the area of the metal tested and the time it was exposed. The life of a pipe cannot be predicted solely from the loss of weight, or the depth of a pit, at any given time. The corrosiveness of the soil can be indicated only by a formula which takes into account the characteristics of the soil to which the pipe is exposed, the change in the rate of corrosion with time and the area of the exposed metal.

Several methods of testing soils and coatings are described and their usefulness discussed. The effectiveness of several methods of preventing corrosion are compared. Cathodic protection can retard or prevent corrosion under most soil conditions. The paper describes methods of applying cathodic protection under several conditions. Details of test methods and apparatus are given in six appendices.

*Modern Foundry Practice,* edited by E. D. Howard, with contributions by ten specialists. Blue binding, 384 pages, over 350 illustrations and diagrams, 5½x8½in. Published by Odhams Press Ltd., Long Acre, London, W. C. 2. Price 8'6.

*Modern Foundry Practice* is outstanding for several reasons: (1) other phases of foundry practice are not subordinated to molding; (2) gray iron foundry techniques are not emphasized to the virtual exclusion of other practices; and (3) mechanization is covered in a separate chapter as well as frequently mentioned throughout the text.

The introduction to *Modern Foundry Practice,* a good general description of the foundry industry, was written by V. C. Faulkner, Editor, *Foundry Trade Journal* (London), and Past President, Institute of British Foundrymen.

Starting with a discussion of ferrous metals, the book covers general metallurgy, heat treatment of both ferrous and non-ferrous alloys, and devotes a chapter to heavy non-ferrous alloys and another to light metals.

The chapter on melting furnaces is well written and nicely illustrated. In the discussion of sand, the fundamentals of sand testing, and valuable information on facings and blackings are given. The sections on molding and molding machines are profusely illustrated. Included are descriptions of pit molding, loam molding and the use of sweeps, as well as the commoner types of molding.

One is disappointed on discovering that the last chapter, devoted to inspection of castings, consists of only two pages.

*Modern Foundry Practice* is sufficiently technical to serve as an engineering college text book. It is also suitable for vocational schools and has found considerable use in

*(Concluded on Page 104)*

## Book Reviews

*(Continued from Page 103)*

apprentice training courses. Covering lightly all the important phases of foundry practice, the book is not encyclopaedic and does not confuse the reader with a mass of detail.

*"Introduction to Magnesium and Its Alloys,"* by John Alico. One hundred eighty-three pages, illustrated. Published by Ziff Davis Publishing Co., 185 N. Wabash Ave., Chicago, November 1, 1945. Price, $5.00.

This is the first attempt by an American author to fully describe the production and use of magnesium and its alloys. As such an attempt, it is well done, presenting the information comprehensively and accurately. The author starts with the historic and economic development of magnesium. He then discusses the occurrence of magnesium and production of magnesium metal; metallurgy of magnesium and its alloys; casting magnesium alloys; forging, rolling, forming and extruding magnesium alloys; heat treatment and surface treatment of magnesium alloys; machining magnesium alloys; and joining magnesium alloys. He concludes the book with a discussion of magnesium as a factor in post-war design.

Naturally, a book which covers the entire field of magnesium and its alloys cannot devote a great deal of space to casting practices. However, Mr. Alico's chapter on casting magnesium alloys has covered most of the fundamentals of magnesium foundry practice. His discussion includes the subjects of fluxing; removal of metallic impurities; melting processes; secondary magnesium; casting methods; sand casting; permanent mold casting; die casting; continuous casting; fire hazards in foundries; and protection of foundry workers.

Each chapter in the book is followed by a bibliography of references, which may be consulted for further information on the subject.

*"Shop Sketching,"* Educational Bulletin No. 2, issued by the Training Dept., Industrial Relations Div., Allis-Chalmers Mfg. Co., Milwaukee.

The ability to make accurate and readable sketches is of considerable importance to all men in industry who have occasion to design parts or equipment. This booklet was prepared for the use of Allis-Chalmers employees to assist them in making better sketches.

The first part of the booklet is devoted to instruction and how to sketch. It discusses such subjects as materials; kinds of lines; how to construct various figures; the sequence of operations in sketching a part; types of projections; how to present the interior of parts; lettering; dimensioning; and construction of corners. The last half of the booklet is devoted to a series of practice lessons, in which the student may apply the principles covered in the first part of the booklet.

The lessons start with simple projects such as making a two-view orthographic sketch of a drafting pencil and advance to more complicated projects.

## New Products

### Protective Compound

*James H. Knapp Co.,* 4920 Loma Vista Ave., Los Angeles 11, has developed a new liquid compound for protection of metal surfaces against oxidation and decarburization during heat treatment within a range of 1200 to 2300° F. Known as "Carbo-Sta," the compound is also designed for use in annealing of brass and copper.

### Plant Sound System

*Stark Sound Engineering Corp.,* Ft. Wayne, Ind., offers a complete portable sound unit with sufficient power to blanket 40,000 sq. ft. of space indoors or carry one and one-half mile outdoors. Equipment is designed for plant managers wishing to act on recommendations of surveys which indicate increased production and other employee relation benefits where music is introduced at various times throughout the day. Communication purposes among personnel are also served with the unit. Amplifier is of late straight-line frequency type resistance, coupled with inverse feed-back circuit electrically mixed. Telescoping speaker column permits adjustment to fifteen feet in height, and to 360° azimuth and 180° zenith movements. Without column, unit is 36 in. maximum width, 42 in. high and 48 in. long. Available on rental or purchase basis.

### Anti-Foaming Agent

*Dow Corning Corporation,* Midland, Mich., has developed a new silicone product, "DC Antifoam A," designed to eliminate undesirable foaming of liquids occurring in industrial operations. Suggested for a wide variety of applications, the inhibitor has been declared suitable for use in cutting oil emulsions in the metal working field. Samples are available upon request.

### Flowmeter

*Bristol Co.,* Waterbury 91, Conn., announces development of the Bel-

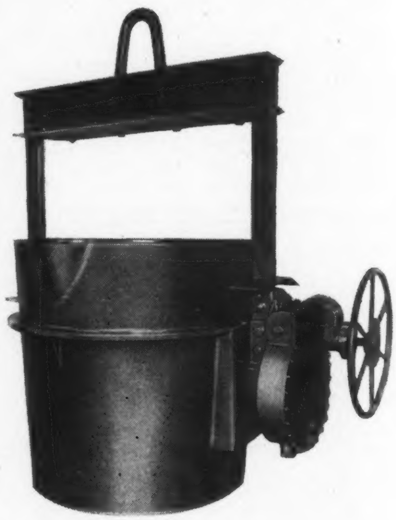
*(Continued on Page 108)*

## New Products
*(Continued from Page 107)*

lows-Differential Flowmeter, available as a mechanical, electrical or pneumatic-transmission flow meter in a complete line of recording, indicating, integrating and automatic control models. Meter body, operating on new principle requires no mercury; and is completely isolated from measured fluid through unique method of transmitting bellows motion to pen arm.

### New Design Ladles

*Whiting Corp.*, Harvey, Ill., announces a new line of all welded construction ladles, featuring trunnions welded to channel-shaped

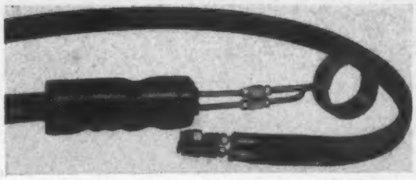


*"Pour-Rite" crane ladle of all welded construction, featuring self-aligning anti-friction bearings in trunnions.*

members to allow air circulation. Type of construction is said to eliminate warpage of trunnion shafts. Trunnion bearings are of the self-aligning, anti-friction type, enclosed in shot and dirt proof housing and provided with shot guards for additional protection. New style gear bracket for tipping has self-locking gearing designed to eliminate backlash.

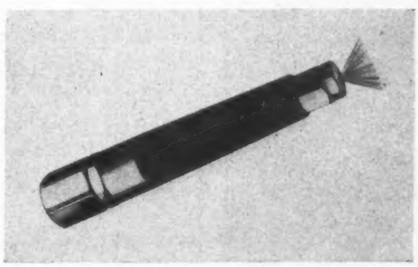
### Flexible Induction Heating Setup

*Induction Heating Corp.*, 389 LaFayette St., New York 3, has de-



*Multi-turn induction heating coil attached to grip handle and flexible transformer leads.*

veloped a flexible lead and coil setup that permits the heating coil to be taken directly to the work. Heating coil is mounted on grip-type handles and connected to a standard "Thermonic" Output Transformer (designed to reduce terminal voltage in coil and thus minimize hazard of arc-over to work) by specially designed leads. Single or multi-turn coils may be used; and arrangement is said to be especially suitable for soldering and brazing small assemblies and tubular parts.



*Hand-operated "Finespray" unit, which provides fingertip control over fine mist of liquid for such operations as application of protective coating to castings.*

### Nozzle

*Lonn Manufacturing Co. Inc.*, East New York St., Indianapolis, has announced a new unit for applications where a fine spray or mist is desired. Known as "Finespray," the lightweight unit can be used for applying coatings to castings or patterns, and is supplied with either ¼ or ⅜-in. connections. Features are: fingertip control without adjustment, slight pressure on flexible nozzle opening valve; flow regulated by hand; and only three working parts, for simplicity in operation and maintenance. Handles only free-flowing liquids, and will operate at low pressures.

## *Index to Advertisers*